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ADEQUATE FOREST FIRE CONTROL

BASED ON A STUDY OF THE CLACKAMAS-MARION PATROL UNIT IN OREGON

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PART I - ANALYSIS OF THE FIRE CONTROL PROBLEM

Description of the area and analysis of fire records, relationship of burning rates to forest management, fire control responsibilities, and finances.

PART II - PLANNING PROCEDURES DEMONSTRATED ON A SAMPLE AREA OF SIX SECTIONS

Methods of testing and improving the fire control facilities and organization.

PART III- RECOMMENDATIONS FOR ATTAINING ADEQUATE FIRE CONTROL

Objectives are stated and recommendations are made concerning the facilities, administration, personnel, and finances required to meet them.

SUPPLEMENT

Recommendations for meeting wartime conditions.

U. S. DEPARTMENT OF AGRICULTURE FOREST SERVICE
PACIFIC NORTHWEST
FOREST AND RANGE EXPERIMENT STATION
STEPHEN N. WYCKOFF, DIRECTOR
PORTLAND, OREGON APRIL 15, 1942

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ADEQUATE FOREST FIRE CONTROL

BASED ON A STUDY OF THE CLACKAMAS-MARION PATROL UNIT IN OREGON

A Progress Report of a Study of Adequate Fire Control on the Private Forest Lands in the Douglas Fir Region of Washington and Oregon

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U. S. Department of Agriculture — Forest Service
Pacific Northwest Forest and Range Experiment Station
Stephen N. Wyckoff, Director

Portland, Oregon — April 15, 1942

FOREWORD

This report on the Clackamas-Marion patrol unit in Oregon is the second of a series of studies of adequate fire control on private forest land by the Pacific Northwest Forest and Range Experiment Station. Differences in terrain, type of forest growth, conditions of human settlement, and legal base as established by State laws which exist among the many administrative units of forest protection in western Washington and western Oregon indicated that the example of a second analysis would be helpful to those who might wish to apply this analytical method to other units. As in the case of the earlier study, that of western Snohomish County, the sample area was selected after field investigation and with the advice of the individuals and organizations who have cooperated on the study.

The present study is more than an analysis of conditions on one area, with recommendations for attaining adequate fire control thereon. The Clackamas-Marion patrol unit is here used merely to illustrate the way in which certain methods of analysis can be applied to attain the desired objectives in comparable situations elsewhere. It endeavors to fulfill the functions of research--the development and expression of principles sufficiently broad to be capable of application within a set of general conditions, thereby making possible the application of those principles elsewhere by others.

With the hope of helping to meet the present emergency a special section has been included in this report which deals with forest protection in wartime. For its duration, war changes many of the premises upon which normal peacetime protection is based. In war, the significance of forest fire changes. In preponderantly forested regions, its effect upon freedom of military action, ease of communication, diversion of civilian manpower from industrial production and other such considerations must be added to the ever-present necessity for protection of a resource upon which so much depends.

As on many other occasions, the Experiment Station has been aided very materially by those upon whom it has called for cooperation and aid in this study. Generous help in selecting the area, in providing many records, and in helpful criticism of the manuscript has been given by the State Forester of Oregon, the Secretary-Manager of the Oregon Forest Fire Association, the Secretary-Treasurer of the Clackamas-Marion Counties Fire Patrol Association, and by members of their organizations.

STEPHEN N. WYCKOFF
Director

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INTRODUCTION

This report is one of the products of the study of fire control on private and associated public lands outside the protection boundaries of the national forests in Washington and Oregon which has been underway at the Pacific Northwest Forest and Range Experiment Station for several years. The purpose is to make an analysis of present fire control as the basis for making recommendations for its improvement that will promote the development of adequate fire control on all forest lands. The study has been conducted on two sample areas. The first sample area was western Snohomish County, Washington, which was the subject of a report already published.1/ The Clackamas-Marion Counties patrol unit in Oregon constitutes the second sample area.

Western Clackamas and Marion Counties were selected because the Fire Patrol Association and the State have been giving private forest lands in these counties a fairly constant level of protection for many years; boundaries, personnel, finances, cover conditions, and other items of importance to an analysis have not been subject to radical changes; the level of protection has been high; this area contains a wide variety of forest conditions; and the fire control problems of forest management range from those of the farmer to those of the large timberland owner and operator.

Throughout this report the term "forest land" is used with the special fire control meaning defined in the Oregon fire laws (sec. 107-201): " . . . 'forest land' means and includes any forest, woodland, brushland, cutover land, slashing, chopping or clearing containing any inflammable forest debris; . . ." The distinction between forest land and agricultural land which is made in this report is only on the basis of present use or present cover conditions. This distinction is not concerned in any way with the intrinsic qualities of the soil, and no attempt has been made to predict the future use of the land.

Part I
ANALYSIS OF THE FIRE CONTROL PROBLEM

DESCRIPTION OF THE SAMPLE UNIT

This analysis is concerned with fire control on all the forest lands outside national forest fire protection boundaries in Clackamas and Marion Counties (fig. 1). Roughly, this area is bounded on the north by Multnomah County and Portland, on the west by the Willamette River, on the south by the Santiam River and Linn County, and on the east by the Mount Hood National Forest. It includes a portion of the highly developed agricultural lands of

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1/ Matthews, Donald N., and Morris, William G. Forest fire control in western Snohomish County, Washington. 77 pp. Portland, Oregon. Pacific Northwest Forest and Range Experiment Station. October 31, 1940. Multigraphed.

the Willamette Valley, rolling hills and foothills of mixed agricultural and forest use and it extends up the lower slopes of the Cascade Range to elevations of two or three thousand feet where all is forest land. The topography is not rugged; gentle slopes are the rule and practically all of the land that is not in agricultural use is capable of producing commercial forests. The unit is near the center of the Douglas-fir region of Washington and Oregon and stands of almost pure Douglas-fir are the predominating forest cover. Climate and soil are both favorable to the rapid growth of timber. Forest lands are mostly in small units of private ownership but there are also a few large private owners and a considerable acreage of Federal, State, and county lands.

The first settlement within the Willamette Valley occurred in these two counties. Some of these lands have felt an impact from civilization for about a century. During this time they have been subjected to the fires of trappers, homesteaders, farmers, loggers, hunters and fishermen, and others. Most of the agricultural land had to be cleared--a tremendous task in which fire played a leading part.

It is difficult to get definite information about the fire history of Clackamas and Marion Counties before 1912 when organized fire control started. But the age and appearance of many stands of timber indicate that there were probably lightning and Indian fires long before the white settlers came. Morris2/ found references to large fires "south of Portland" in 1857 and again in 1868. He found that according to the newspapers of the time, 1902 must have been a disastrous fire year in Clackamas County, probably the worst after it was settled. "Scores of farmers in the territory east and south of Portland for a distance of 40 miles lost their homes, barns, stock, and fences in many separate fires." Among the Clackamas County communities that were mentioned in the newspapers of 1902 as having suffered fire losses were: Molalla, Springwater, Dodge, Highland, Viola, Logan, Eagle Creek, Damascus, Kelso, and Dover. The age of many thousands of acres of today's stands of second-growth timber indicates that they started soon after 1902. The Forest Survey reported 62,000 acres of timber in the 30-year age class in Clackamas County in 1933. There is evidence in Marion County's timber stands and deforested burns that it also had large fires in 1902. The following statement by P. S. Brumby indicates the great changes in public sentiment since those early years:

> "At that time there was no fire patrol, no fire laws, timber was so cheap it was not considered worth while to go to any expense to protect it. Ranchers were allowed to burn any place throughout the whole dry season--anything to clear an opening to get a little grazing land was considered legitimate business. The timber owner who had nerve enough to declare any rights in the country was looked upon with suspicion and declared to be a fraud and a thief, . . ."3/

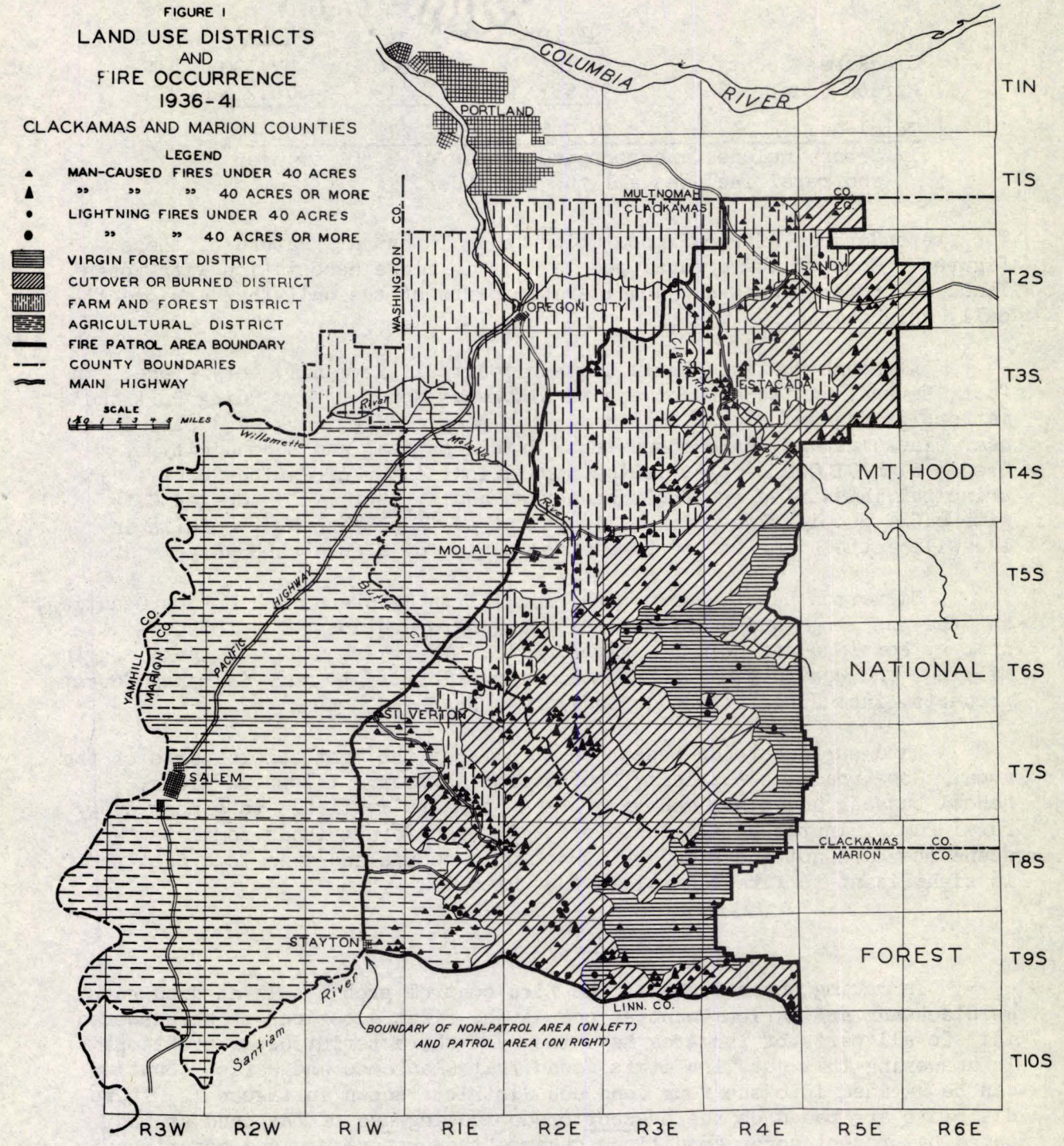
2/ Morris, William G. Forest fires in Oregon and Washington. The Oregon Historical Quarterly. December 1934.

3/ Tanner, E. B. Forestry on its way. In Report of Oregon Forest Fire Association, 1938.

FIGURE 1

LAND USE DISTRICTS AND FIRE OCCURRENCE 1936-41

CLACKAMAS AND MARION COUNTIES



Today this is a region of growing population. During the 10 years prior to the 1940 census the population of both Clackamas and Marion Counties increased 24 percent and this growth occurred in the rural districts as well as in the cities and towns. The 1940 census reveals the following population figures:

	Urban[1/]	Rural[1/]	Total
Clackamas County	6,124	51,006	57,130
Marion County	33,833	41,413	75,246
Total	39,957	92,419	132,376

1/ Urban includes incorporated places of 2,500 or over and rural includes all the remainder.

The preponderance of rural population is an important feature of these figures. Most of these rural people live in close association with forest land. There are, however, considerable parts of the unit that are practically uninhabited.

Although Portland is in another county it is really very close; in fact, several of its suburbs are in Clackamas County. Including Portland's metropolitan area, almost half a million people live, work, and play in or near Clackamas and Marion Counties. Salem, capital and second city of Oregon with 31,000 people, is the population center of Marion County. Its principal industries are fruit canneries and a paper mill. Oregon City with 6,000 people, two paper mills and other industries at the falls in the Willamette River is the population center of Clackamas County.

Silverton has the only large sawmill in Clackamas and Marion Counties, but the one large and numerous small logging operations help to supply the near-by Portland and Columbia River mills. There are numerous small logging, milling, and woodcutting operations. Accessibility to markets makes forest products, including fuelwood, readily marketable.

Hard-surface roads penetrate to all but the most remote parts of the area. Good roads, electricity, rural free delivery, telephone lines, school busses, and other modern conveniences are available to almost every rural family in the unit. Therefore, although forest lands dominate the scene they are not inhabited by a backwoods people and this is a fact that is significant to fire control in the unit.

LAND USE DISTRICTS

In making an analysis of the fire control problems in an area such as Clackamas and Marion Counties one of the first questions to be answered is: Do all parts of the area have the same characteristics or problems? In answering this question it is found that Clackamas and Marion Counties can be divided into the four land use districts shown in figure 1. These districts are based on the present predominating use of the land as indicated by present cover conditions because the present use and cover conditions determine the characteristics of the fire control problems within

the boundaries of each district. In drawing up these districts there is no intent whatsoever to forecast or indicate what the future use of the land will be or should be. The four land use districts are named and described as follows:

1. Virgin forest district. Predominantly (90 percent or more by area) virgin forest or large second growth over 60 years old (pl. 1).

2. Cut-over or burned district. Forest land predominates but it consists principally of cutovers, burns, and second growth under 60 years old (pl. 2). This district contains considerable agricultural and virgin forest lands in islands too small to be eliminated under the general specifications of a district.

3. Farm and forest district. A mixture of agricultural and forest lands in approximately equal quantities without large pure concentrations of either one (pl. 3).

4. Agricultural district. Lands predominantly devoted to agricultural use (pl. 4).

The districts were outlined on a cover map using the following specifications:

(a) Agricultural lands include cultivated fields, orchards, and improved pastures. They also include towns and villages. Probably pastures occupy considerably more than half of the area of the lands classed as agricultural.

(b) The minimum width of a district shall be one mile.

(c) The minimum area to be shown as an island shall be about 2,500 acres.

The total gross area of Clackamas and Marion Counties outside the national forest protection boundary (fig. 1) is divided among the four land use districts as follows:

Land use district	Gross area Acres[1]	Percent
Virgin forest	85,000	7
Cut-over or burned	302,000	26
Farm and forest	297,000	26
Agricultural	464,000	41
All districts	1,148,000	100

1/ Acreage figures in this and following tabulations are approximations based on the assumption that sections contain 640 acres.

The virgin forest district is practically uninhabited. The cut-over or burned district is very sparsely settled with agricultural development tending to be concentrated in the most favorable spots. The farm

and forest district contains a considerable population. The agricultural district is densely populated. Since fire control in these districts encounters social and economic problems as well as physical problems some attention was paid to living conditions, especially those prevailing in the cut-over or burned and the farm and forest districts. Some of the more significant facts about living conditions in these districts are revealed in table 1, which is based on a quick roadside survey of 257 rural homes about equally divided between the two districts.

Reviewing briefly table 1 it is indicated that 50 percent of the homes in the cut-over district have electricity while only 21 percent have telephones. Perhaps rural telephones have gone into a decline in recent years. The fact that only one family in five has a telephone has important effects upon the administration of fire control in this district. It is difficult for the people to communicate with the warden and for him to do business with them. Although most rural people burn out a stump or two or do some clean-up on their lands every year there were apparently no land clearing operations involving an acre or more at the time of the investigation. However, there is land clearing in the unit. Twenty percent of the pastures in the farm-forest district and 47 percent in the cut-over or burned district were found to be reverting to forest. If these pastures were left to themselves unaffected by fire or clearing they would soon have a forest cover. Practically none of the land that had ever been plowed in the farm and forest district was reverting to forest and only 12 percent of the rural homes in the other district had plowed lands reverting to forest.

Table 1.--Survey of the living and land conditions of 257 rural home units in the Clackamas-Marion patrol unit

Living and land conditions	Land use districts	
	Farm and forest	Cut-over or burned
	Percent	Percent
Electricity in house	74	50
Telephone	39	21
Type of house		
One room	17	35
2-4 rooms	43	36
5 or more rooms	40	29
	100	100
Land being cleared	0	1
Pastures reverting to forest	20	47
Without pasture land	22	31
Plowed land reverting to forest	1	12
Without plow land	16	31
House unoccupied	7	15
Rock road within 1/8 mile of house	100	100
Forest land within 1/4 mile of house	96	100

Plate 1.--Virgin forest land use district in Clackamas County

Plate 2.--Aerial view of cut-over or burned land use district in Clackamas County

Fifteen percent of the houses in the cut-over district were apparently unoccupied. This is probably normal for this type of land. The table bears out the general observation that practically every home in the unit, even those in remote places, has an all-year rock road to its door. It also indicates that practically all the homes are located very close to forest land. In most cases they are so close that a fire on the forest land would be a serious menace to the home buildings. The close relation between homes and forest lands gives the residents a direct interest in forest fire control and it also makes it possible for residents to find and report and in some cases put out forest fires very readily. The table also indicates that a good many rural residents have neither pasture land nor plow land. The sample included many cabins evidently built by city folk for recreational use and few of these places have much land of any kind. There are also a considerable number of woods workers and others living on forest lands without pastures or plow land. The above gives a very brief picture of how people and their fields and their houses are related to the forest lands of the farm and forest and the cut-over or burned-over districts.

PROTECTION STATUS

Fire control and its administration is not the same in all parts of Clackamas and Marion Counties. Under its discretionary powers the State Board of Forestry several years ago established two distinct areas based partly on the occurrence of forest cover, the use of the land, and administrative considerations. One was called the patrol area and the other the non-patrol area. This division is shown in figure 1. The name "patrol area" was probably derived from the fact that owners of forest land therein had to pay the fire patrol assessments unless they met their obligation to provide protection by supporting a fire patrol association or, under a law recently revoked, established their right to residence exemption. The patrol area was the territory of the Clackamas-Marion Counties Fire Patrol Association with its own warden and administration organization. Fire patrol assessments were not collected from forest lands in the non-patrol area, and the county protected part of this area. Protection of the non-patrol area has recently been undergoing changes. The patrol area contains most of the forest land in Clackamas and Marion Counties, outside the national forest protection boundaries, and it received most of the attention in this study. However, the non-patrol area has its own forest fire problems and they will be discussed under the next heading and then practically all the remainder of this report will deal with the patrol area.

Non-Patrol Area

The non-patrol area (fig. 1) has a gross area of 535,000 acres divided between two land use districts as follows:

	Acres	Percent
Farm and forest district	142,000	27
Agricultural district	393,000	73
Total	535,000	100

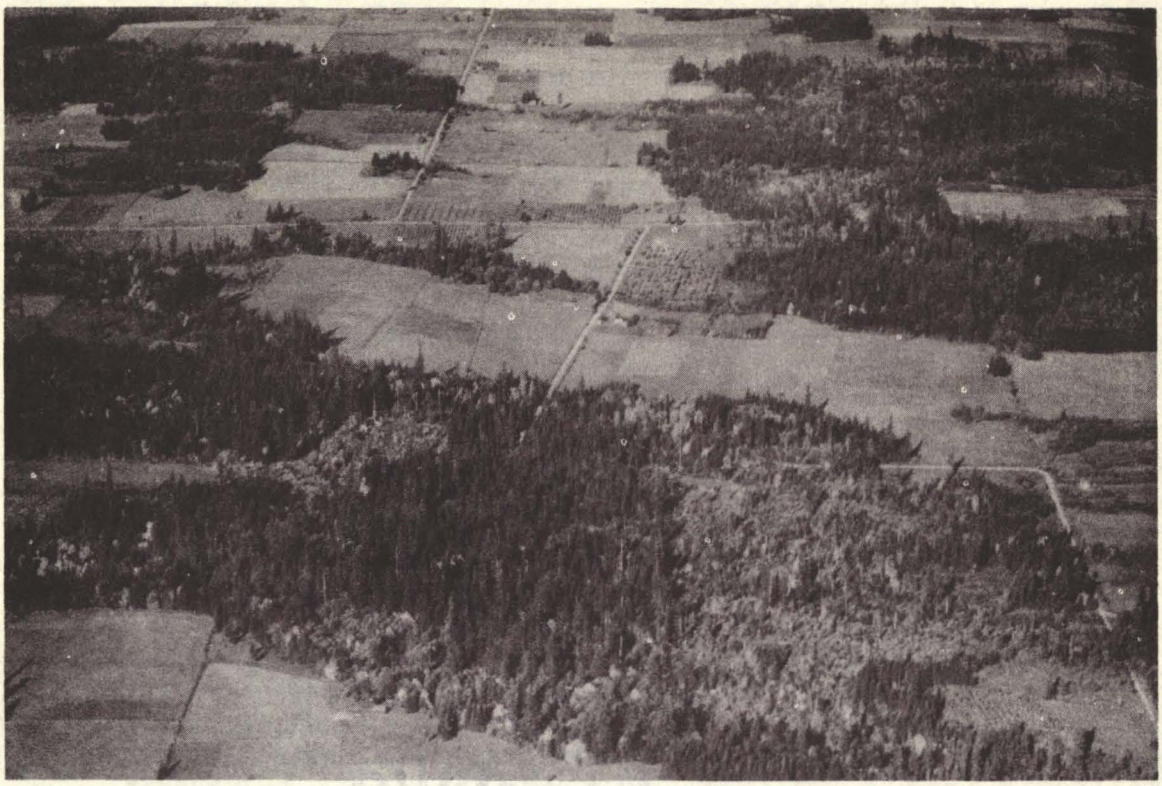


Plate 3.--Aerial view of farm and forest land use district in Clackamas County

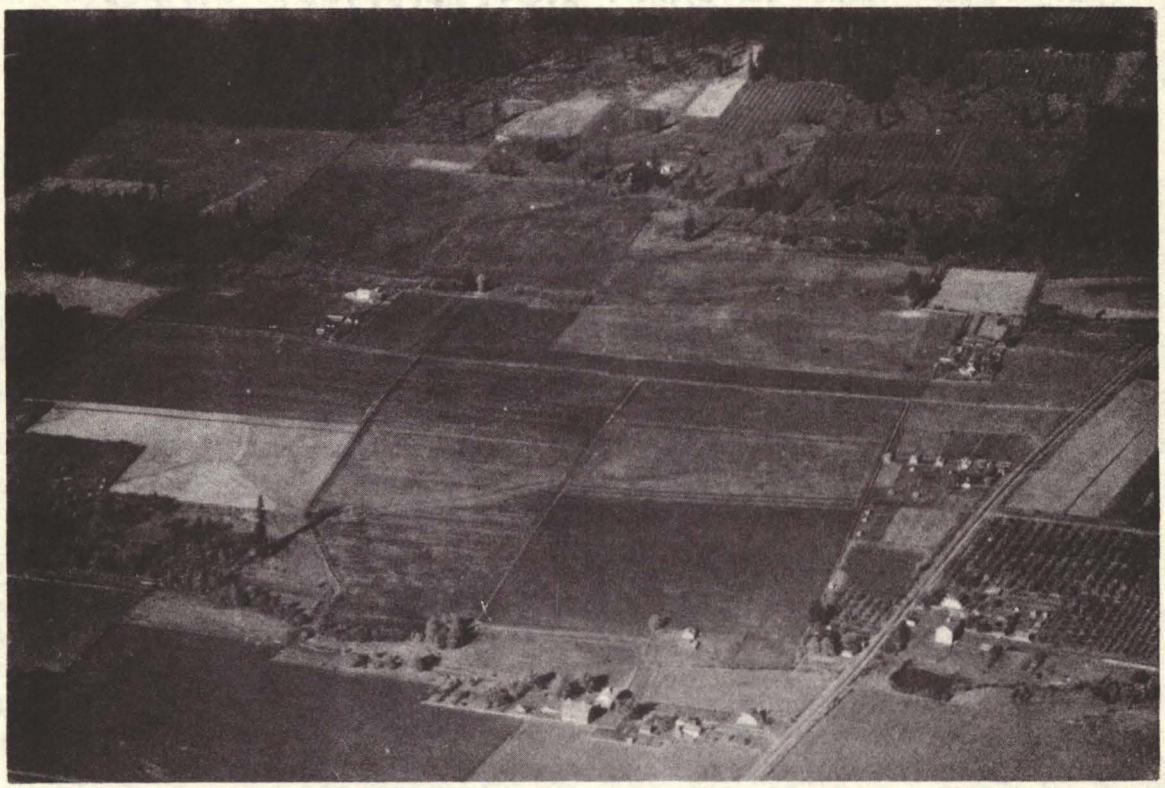


Plate 4.--Aerial view of agricultural land use district in Clackamas County

The amount of forest land involved is indicated by the fact that in the non-patrol area the farm and forest district contains by conservative estimate about 40 percent and the agricultural district about 25 percent forest land. Applying these percentages to the above district acreages indicates a total of at least 155,000 acres of forest land in the non-patrol area. This forest land occurs as islands of a few acres on Willamette Valley farms, as narrow or wide stringers along streams or hillsides, and occasionally in connected bodies aggregating several thousand acres. It runs a complete range from nonrestocked stump pastures to old-growth timber, it is exposed to numerous fire-starting agencies, and it is susceptible to damage by fire.

Although during the years covered by this study the non-patrol area did not have organized State protection, certain of the State forest fire laws applied and the State Board of Forestry recognized that it had certain fire control responsibilities. Fires in the non-patrol area of Clackamas County were handled by an employee of the county who was appointed as a State fire warden. A fully equipped fire truck was provided in 1941. Fires in the non-patrol area in Marion County were handled by the State Forester's Office in Salem. Burning permits were required but operating permits were not required. Support of fire control within this area came from State or county funds because property owners were not required to pay a fire patrol assessment.

Some indication of the extent of the fire problem in the non-patrol area is revealed by the fact that in 1940 there were 67 fires handled by the Clackamas County warden and these fires burned over 2,021 acres. The largest fire burned about 1,200 acres. Since the non-patrol area lies outside of organized State protection such fires have not been included in the State Forester's annual reports.

Until very recently there were only two types of areas in Oregon with organized fire control. Municipal fire departments provided protection for properties within the boundaries of their respective municipalities and would answer some calls beyond these boundaries. The second type of fire control was that developed for large areas of timber and forest lands. Obviously these two types of fire control did not serve all properties needing protection. They provided protection for the concentrations of valuable properties in the cities, towns, and villages and for the large concentrations of forest lands, but combustible properties in the suburbs of cities, on farms, and the forest lands intermingled with farms were practically without organized fire control. Forest, brush and grass fires in this unorganized territory were fought by the local residents with the contributed help of county road crews, sheriffs and State police.

So far this discussion of fire control in the non-patrol area has dealt with the situation as it was in the past. Due to several "bad" forest fires in non-patrol areas in various counties in recent years and due to a growing demand for protection of rural properties this situation has been changing rapidly. County courts and the State Fire Marshal's Office have taken an interest in the problem. The 1941 legislature passed a law providing for the zoning for fire control purposes of all lands

"lying outside the boundaries of incorporated cities and towns, organized rural fire protection districts and federal and state owned lands" and lands protected in forest fire patrol districts. "Such lands shall be divided into two zones as follows: Zone 1 shall be composed of forest lands intermingled with grazing and agricultural lands or either of them; zone 2 shall be composed of rural lands not included in zone 1." In zone 1 the protection of forest lands is a major part of the fire control job. The State Board of Forestry may establish fire control districts in zone 1, include zone 1 lands within present patrol districts or contract their protection. Protection costs for zone 1 lands are collectible the same as fire patrol assessments but shall not exceed 5 cents per acre. Within zone 2, in which buildings are a major concern of protection and forest lands are less prominent than in zone 1, the county court or board of county commissioners is responsible for fire control and may establish fire fighting facilities or contract with other agencies to furnish this protection. The county is authorized to raise funds for the protection of zone 2 properties by levying a tax of not to exceed 4 mills on the assessed valuation of zone 2 lands.

This recent legislation opens the way for the development of fire control for all lands. However, the law simply authorizes the county officials and the State Board of Forestry to do certain things. The weakness is that zoning and fire protection are optional. The law does not require universal fire control. All of Clackamas County lying in the non-patrol area has recently been classified by the county court as a zone 2 area and will receive more intensive protection than in the past. The western part of Marion County has not been classified under this law; therefore it retains its former non-patrol status. The need is for fire control for all properties and until this is provided the protection of forest lands and other properties within the Marion County non-patrol area will probably not be adequate or satisfactory.

Patrol Area

The gross area of the Clackamas-Marion patrol unit is approximately 613,000 acres and as indicated in table 2, 76 percent or 468,000 acres may be classed as forest land as defined at the beginning of this report. The amount and location of this forest land was determined by field examination and use of forest survey type maps. The distribution of this forest land among the land use districts is shown in table 2.

The over-all protection status of the patrol area is indicated by the statement that all of it is protected by the Clackamas-Marion Counties Fire Patrol Association, Incorporated, a non-profit organization. Analysis reveals, however, that lands within the area support the Association in several very different ways or fail to support it entirely. All the forest land in the patrol area falls into one of the following protection status classes:

Association. Lands whose owners pay directly to the Association for fire control.

Tax roll. A term used with restricted meaning in fire control to designate lands on the tax rolls against which there is levied a "fire patrol assessment" to be collected by the county and paid to the State because they are not otherwise protected. In the Clackamas-Marion patrol unit the protection of these lands is contracted by the State to the Association.

State. Lands owned by the State, principally State forest and State park land.

County. County owned forest lands mostly acquired by delinquent tax foreclosures.

National forest. National forest lands in the patrol area protected by the Association in exchange for non-national-forest lands inside the national forest protection boundary protected by the national forest.

Other Federal. Revested Oregon and California Railroad grant lands and public domain lands protected by the Association under contract with the Federal government.

Nonpaying. Forest lands which do not contribute to the support of forest fire control because the owners are delinquent in the payment of the fire patrol assessments or for other reasons.

Table 2.--Distribution of forest land among land use districts in Clackamas-Marion patrol unit

Land use district	Gross area	Forest land		
		Area	Division among districts	Proportion within each district
	Acres	Acres	Percent	Percent
Virgin forest	85,000	85,000	18	100
Cut-over or burned	302,000	287,000	62	95
Farm and forest	155,000	86,000	18	55
Agricultural	71,000	10,000	2	14
All districts	613,000	468,000	100	76

Table 3 summarizes the protection status of all the land, forest land and agricultural land, in the Clackamas-Marion patrol unit. It indicates that none of the 145,000 acres of agricultural lands in the patrol unit contributes to the support of fire control although the State forest fire laws make the warden responsible for fire control upon them. He controls fires, issues burning permits and renders other services on these nonforest, noncontributing lands. Since, broadly speaking, all lands--forest lands, grain fields, stubble, grass, etc.--require and get some measure of service from the fire control agency every nonpaying acre tends to increase the burden on the paying acreage.

Table 3.--Protection status of all land in the Clackamas-Marion patrol unit1/

Protection status	Area	
	Acres	Percent
Forest land - paying		
Association	106,000	23
Tax roll	189,500	40
State	5,000	1
County	5,000	1
National forest	5,500	1
Other Federal	68,000	15
Subtotal - Forest land paying	379,000	81
Forest land - nonpaying	89,000	19
Subtotal - Forest land	468,000	100
Agricultural land - nonpaying	145,000	-
Total	613,000	-

1/ Acreage of Association, State, county, national forest and other Federal forest lands based on 1940 Association report. Acreage of paying tax roll lands based on average of tax roll receipts given in Association reports from 1938 to 1940. Total acreage of nonpaying forest land determined by subtracting the total acreage of paying forest lands from the total acreage of forest lands found by field inspection and use of forest survey type maps. Acreage of agricultural land was also determined by field inspection and use of forest survey type maps.

Since this is an Association unit and one of the oldest in the State, established in 1912, it is interesting to note in table 3 that only 23 percent of the paying forest lands protected are classed as "Association" while 40 percent are classed as "tax roll." The lands whose owners manage the affairs of the Association and make direct contributions toward its financial support total far less than the paying tax roll lands. The Association is supported mostly by the large owners while the tax roll lands are characterized by many small owners. There are about 30 members of the Association and 3,500 owners of paying and nonpaying tax roll lands. Therefore a very small minority of the landowners constitute the Association, which is the protection agency for the unit. Owners of tax roll lands are not represented in the Association except through the State Board of Forestry and the State Forester, who contracts the protection of their lands to the Association. This subject is discussed further under the heading "Division of Responsibility."

The type of land owned by Association members is also significant. Table 4 indicates that the comparatively small virgin forest district with

its high per-acre values in merchantable timber contains 45 percent of the total Association acreage which is 57 percent of the total area of that district. If the 21,000 acres of publicly owned lands in the virgin forest district are eliminated then the Association is supported by 75 percent of the total acreage of the private lands of that district. The Associations were originally formed primarily for the protection of merchantable timber, and it is apparent that this is still a major interest of the members of the Clackamas-Marion Counties Fire Patrol Association. Since several thousand acres of timber are cut over each year it is indicated that the Association acreage will shrink.

Table 4.--Distribution of Association lands among the land use districts in the Clackamas-Marion patrol unit

Land use district	Total forest land in each district	Association acreage		
		Area	Division among districts	Amount within each district
	Acres	Acres	Percent	Percent
Virgin forest	85,000	48,000	45	57
Cut-over or burned	287,000	54,000	51	19
Farm and forest	86,000	4,000	4	5
Agricultural	10,000	0	0	0
All districts	468,000	106,000	100	23

The distribution of the tax roll acreage is shown in table 5. This table is based on the lists prepared in 1941, which include forest lands formerly nonpaying because of residence exemption. The procedure is for the State Forester to prepare these lists and furnish copies to the county assessors who then extend the lands upon the tax rolls. Since only forest land is listed to pay the patrol tax its definition and determination becomes an important matter. The present practice is to follow the assessor's classification of lands and to list for patrol tax all unimproved or uncultivated lands. No field examination is made, but preparing the tax roll lists each year and following through on the collection of the patrol tax is a considerable job because of the number of pieces of land involved. The current lists for Clackamas and Marion Counties contain the names of about 3,500 landowners. Many individual entries are for less than 10 acres, very few cover as much as 320 acres, and the average is for 73 acres, which at 4 cents per acre would bring in $2.92 per year. Obviously the collection procedure must be simple or its cost will consume too large a proportion of the assessment.

Table 5.--Distribution of tax roll lands among the land use districts in the Clackamas-Marion patrol unit. Based on 1941 lists which include lands formerly nonpaying because of residence exemption

Land use district	Total forest land in each district	Tax roll acreage		
		Area	Division among districts	Amount within each district
	Acres	Acres	Percent	Percent
Virgin forest	85,000	13,000	5	15
Cut-over or burned	287,000	143,000	57	50
Farm and forest	86,000	85,000	33	99
Agricultural	10,000	1/ 13,000	5	-
All districts	468,000	254,000	100	54

1/ The apparent discrepancy in this entry between "total forest land in each district" and "tax roll acreage" is probably a matter of definition and method used to determine the acreage. The "total forest land in each district" was obtained from forest survey type maps and field mapping; the tax roll acreage apparently includes all lands except those that are cultivated.

PERMITS

Two kinds of permits, burning permits and operating permits, have an important place in forest fire control in Oregon and they were studied in the Clackamas-Marion patrol unit.

Burning Permits

Under Oregon law, during the closed season (May 15 to December 31 but subject to change by the Governor upon advice of the State Forester) "it shall be unlawful for anyone to set on fire . . . any forest land, grass, grain or stubble . . . within 1/8 mile of forest land . . . without first securing a written or printed permit from the forester or a warden and complying with the terms thereof . . . and the forester or any warden may prescribe the conditions upon which the permit is issued and which are necessary to be observed in setting such fire and preventing it from spreading . . ." The State Forester's Report indicates that 2,249 burning permits were issued in the non-patrol, patrol and national forest areas in Clackamas and Marion Counties in 1940. These include permits issued for the burning of logging, woodcutting and land-clearing slash during the closed season, some of which may involve considerable acreages. The largest area involved in any single permit in 1940 was 1,020 acres. Permits are also issued for the burning of stubble, straw, grass, weeds, trash, rubbish, berry brush, piled brush, unpiled brush, stumps, logs and roots. Permits are not required during the open season; therefore they do not represent the total amount of burning being done. In table 6, 1,064 of these permits are analyzed to give a sample of their size and distribution.

Table 6.--Distribution of a sample of 1,064 burning permits by size and by land use districts, Clackamas-Marion patrol unit, 1940

Districts	Number of permits classified by acreage involved in each				Area of larger permits
	0-1 acre	1+ to 5 acres	Over 5 acres	Total	
					Acres
Patrol unit					
Virgin forest	4	0	3	7	40, 45
Cut-over or burned	114	50	40	204	40, 300, 280, 200, 400, 1020
Farm and forest	158	68	36	262	180, 50, 40
Agricultural	33	24	18	75	90, 30
Subtotal	309	142	97	548	2,715
Non-patrol area					
Farm and forest	250	100	30	380	200, 160, 30, 50, 50
Agricultural	50	21	65	136	105, 130, 80, 110, 40, 50, 40, 20, 20, 300, 30, 50
Subtotal	300	121	95	516	1,465
Total	609	263	192	1,064	4,180

Issuing and administering burning permits is one of the most important of the warden's duties and one which requires the expenditure of a considerable amount of time. Before issuing a permit the warden must satisfy himself that the burning can be conducted without getting out of control. In most cases this means that he actually visits the scene of the proposed fire before issuing the permit and he may also make suggestions about proper preparations for burning and the proper time to burn. These special requirements are made a part of the permit. When it seems necessary the warden assists with the burning without cost to the permittee but he does not assume any liability for what the fire may do. It is the warden's policy to help the operators and settlers do their burning rather than to discourage or obstruct their burning. But it is also his policy to get the burning done safely.

It should be evident from even this brief explanation of burning permits that they are an important instrument for successful fire control. They give the warden control over the use of fire for legitimate purposes where this use may be dangerous to other properties. They bring him into direct contact with farmers, forest residents, woodcutters, right-of-way clearers, sawmill men, and loggers at a time when they are most likely to be receptive to suggestion, advice, instruction or demonstration about the

safe use of fire. Every burning permit represents an excellent fire prevention opportunity.

Although burning permits are undoubtedly an important fire control device, they are strictly a fire control device and the good or harm to be accomplished by burning does not enter into the issuing of a permit. Permitted fires often contribute to unwise land use and undesirable land management practices. Burning straw and stubble may be a bad practice for the farmer and burning bracken to make pasture for a year or two may be harmful to the land by favoring erosion and prevent its reforestation where producing a forest crop is its highest use, but the burning permit law is not concerned with these matters in any way whatsoever and they are not considered when a permit is issued. Therefore some of the permit fires should be considered with other fires when determining the total depletion due to fire on the forest lands of the Clackamas-Marion patrol unit. Since the total area burned per year under permit far exceeds the total area burned per year by ordinary forest fires--compare tables 6 and 8--permit fires may actually have a much greater effect upon the forest lands of the unit than forest fires.

Operating Permits

Since 1933 Oregon laws have provided " . . . it shall be unlawful for any person to use fire in any form or to use any power-driven machinery in sawmilling, logging . . . or other operation on or within one-eighth of a mile of forest land . . without first having obtained a written permit . . ." from the State Forester. Formerly these permits were required only in the closed season, but the laws of 1941 require them for the entire year. In brief, the permit requires that the permittee shall use every reasonable precaution to prevent the start or spread of fire, he shall close down during dangerous weather, he shall have a representative on the operation at all times, he shall furnish "such weather instruments as the state forester may prescribe as adequate in his judgment to determine the relative humidity and temperature of the air and the direction of the wind" at a cost not to exceed $25, the permittee shall designate by legal subdivisions the area to be operated upon, he shall keep his operating area free of excessive debris in so far as directed by the State Forester, and he shall comply with the other forest laws of the State. The other forest laws require many precautions against the start and spread of fire such as annually cleaning up the slashing unless released by the State Forester, felling snags, guarding against the escape of sparks and kindling of fire from power-driven machinery, and providing tools and equipment to suppress fires. They also provide that an operator shall use every possible effort to stop a fire that starts.

In 1940 there were 185 operating permits issued in the Clackamas-Marion patrol unit and they involved a gross area of 34,710 acres. These permits were for woods operations and do not include those for sawmills. These gross area figures do not represent net acres cut over or operated upon in this one year. Actually there are about 9,000 acres cut over in the patrol unit per year. The area specified in the permits includes lands actually operated upon and other lands subject to the special fire

control requirements in the permit. Permits are issued for a minimum of 40 acres unless an operator owns less than that amount of land. The smallest permit was for 5 and the largest for 3,000 acres. Permits are required of even very small operators such as woodcutters if they use power-driven machinery. The total number of 1940 permits was distributed by land use districts as follows: Virgin forest 8 percent, cut-over or burned 70 percent, farm and forest 21 percent, and agricultural district 1 percent. Operating permits have not been required in the non-patrol area. The State Forester issues the permits and his inspectors, not the fire warden, make the two or more inspections per year that are necessary and enforce the requirements of the operating permits relative to fire precautions, fire tools, closing down during hazardous weather, snag falling and slash disposal.

Discussion of Permits

Although the permit laws are effective fire control devices the objective of preventing fire losses could be more nearly attained if the fire control agency would do more of the actual burning or hazard reduction or provide more of the intensive protection where that is necessary. The permittee would be expected to pay his share of any such special services provided by the protection agency. The protection agencies are already giving considerable assistance with slash disposal and the conduct of burning under permit. In the interests of obtaining positive prevention of fire losses due to unskillful, ill-timed, or delayed burning it would be highly desirable for the protection agency to participate in this work even more than at present. Hazard reduction by burning is very often an extremely dangerous undertaking and it should be fully supervised by skillful, experienced men who are competent to do the job with safety. Satisfactory results cannot be obtained by delegating the job to every permittee. The best results should be obtained by the fullest practicable participation of the fire control agency. Such participation in hazard reduction would also enable the fire control agency to give some of its employees a longer period of employment each year and would be very important in training and holding a strong protection force.

The contribution which the permit laws could make to fire control would be increased if they required some showing as to financial responsibility as a condition for obtaining a permit. At present permits are granted without any consideration of financial ability or responsibility and a permittee who is not solvent may create a hazard that will develop into a fire that will cost several thousand dollars to control and which may destroy thousands of dollars' worth of other people's property. Or a permittee may create a hazard, dissolve his business and leave the hazard unabated. Therefore the permit laws might be made more effective fire control devices if they required and enabled the permittee to make some reasonable advance guarantee of his financial responsibility as a prerequisite to obtaining a permit.

It is not just or satisfactory to require permits for some activities on forest lands and to allow others equally dangerous to continue without restriction. Many fire control authorities consider the unrestricted

use of forest land by the public to be a major obstacle to the attainment of adequate fire control and therefore a major obstacle to forest management. During Oregon's recent pioneer past, forest land was part of the public's domain, used and abused freely by anyone without permission or hindrance. But such free use of forest land is not compatible with intensive forest management. Today most forest land is in definite private or public ownership. Therefore much of today's use of forest land by the public--berrypickers, fishermen, hunters, hikers, etc.--is in fact trespass. Forest land owners and forest fire control agencies must take positive measures to prevent this very common trespass from becoming established as a public "right" by custom and habit. Some form of permit system would be helpful in clearly establishing that public use of private land is a privilege and not a right. At the same time it would give the fire control agency control over the public use of private land as a very important fire prevention measure. Closures are, in fact, a step in this direction, but the experience in older countries indicates that successful forest management requires far more control over the public use of forest land than has been customary here.

FIRE WEATHER

Because there are no weather or fire danger stations within the Clackamas-Marion patrol unit with sufficient records for the purpose no detailed analysis of these important factors was attempted. Suggestions for developing and using a fire danger rating system will be included in a later section of this report.

It can be stated that this unit is not subject to any exceptional fire hazard due to climatic factors. It is quite similar to neighboring areas to the north and south, except that it is somewhat closer to the Columbia Gorge than other units in western Oregon so that part of it at least is affected by the dry east winds that pour out of the Gorge and produce the most dangerous fire weather experienced in western Oregon and Washington. However, most of the Clackamas-Marion patrol unit is not in the direct path of these winds and it is probably much less seriously affected by them than, for example, Multnomah or Columbia County. The fire records themselves indicate that dangerous burning conditions have occurred in all months from February to November inclusive, but this does not mean that there is a continuous fire season for any such length of time. The main fire season corresponds, of course, to the drought that usually occurs in July and August and which may extend on into September or later. In addition to this major period of fire danger there may be shorter periods earlier or later in the year which are usually separated from the summer drought period by days or weeks of damp, rainy weather. Full recognition of the changes taking place and exact knowledge about burning conditions existing on any given day are essential to successful fire control because of their importance in handling controlled burning (burning permits) and all fire prevention and suppression activities.

COVER AND FUEL TYPES

A combination cover and fuel type classification was used to make a rough classification of the different fuel conditions within the patrol unit that would be significant for making fire control plans. All lands were allocated to one of the following three classes:

1. Low hazard forest types. Dense stands of old-growth or second-growth timber which fully shade the forest floor and have a low or moderate fire hazard. Do not contain any large masses of fuels from recent fires or recent cutting. Combined hazard rating--rate of spread times resistance to control--usually 10 or less on a scale of 0 to 1000. Includes Forest Survey types, stocking and ages: 6; 7; 8; 9≡ and 9=, all ages; 10≡, 10=, 15≡, 15=, 16≡, 16=, 19, and 24, age 20 years and over; 14; 17; 23; 31; and 31.5.4/

2. High hazard forest types. Forest types and cover conditions which permit the fuels to be exposed to the effect of sun and wind or with large quantities of fuel or both. Usually this condition is the result of fire or cutting. Includes a small amount of "extreme" hazard types which were not classified separately. Combined hazard rating varies from 10 (MM) on recently burned lands without snags to 1000 (XX) for fresh unburned slash on a scale of 0 to 1000. Will probably average about 10 times the combined rating of the low hazard types. Includes Forest Survey types, stocking and ages: 9-, 10-, 15-, 16- (poor stocking), all ages; 10≡, 10=, 15≡, 15=, 19, and 24, under 20 years old; and types 35, 36, and 37.

3. Agricultural types. Cultivated lands, improved pastures and lands occupied by buildings, villages and towns. (Forest Survey type 3.) Includes a wide variety of cover types; some of them--for example, grain, grass, and bracken--highly inflammable, high or extreme rate of spread and low or moderate resistance to control, 25 to 250 combined rating on a scale of 0 to 1000, and others such as close-cropped green pastures, summer fallow, cultivated crops, and orchards relatively noninflammable and capable of acting as excellent firebreaks.

Significant facts revealed in table 7 are that the virgin forest district is practically all low hazard and that there is a large proportion of high hazard types in the cut-over district. The fact that in the entire patrol unit only 30 percent of the area is classed as high hazard indicates relatively favorable conditions for fire control. For detailed planning purposes it would be desirable to subdivide these cover and fuel types, especially the wide variety of types included here as high hazard, in order to provide special protection for the unburned slash, snag areas, and other of the most dangerous types.

4/ ≡, =, and - indicate full, moderate, and poor stocking respectively.

Table 7.--Cover and fuel types within each land use district in the Clackamas-Marion patrol unit

Cover and fuel types	Land use districts and area in acres				
	Virgin forest 85,000 ac.	Cut-over 302,000 ac.	Farm and forest 155,000 ac.	Agricultural 71,000 ac.	Total 613,000 ac.
	Percentages				
Low hazard	97	50	30	5	46
High hazard	3	45	25	9	30
Agricultural	0	5	45	86	24
Total	100	100	100	100	100

FIRE OCCURRENCE AND BURNING RATES

The number of fires and the number of acres burned per year in the Clackamas-Marion Counties patrol unit from 1921 to 1941 inclusive are shown in table 8. The records revealed in this table indicate that the average area burned per year has been decreasing but the number of fires per year has been nearly constant. The table can be used to show that from 1921 to 1931 inclusive there was an average of 74 fires and 4,975 acres burned per year while in the recent years from 1932 to 1941 inclusive there was an average of 75 fires and only 1,843 acres burned per year. During the past five years, 1937 to 1941 inclusive, there was an average of 81 fires and only 251 acres burned per year; and on the 468,000 acres of forest land protected this indicates a burning rate of less than 1/10 of 1 percent per year. During the 21-year period included in the table the burning rate averaged about 3/4 of 1 percent, which is three times the 1/4 of 1 percent burning rate usually accepted as allowable in the Douglas-fir region.

The location and size of all fires which occurred in this area from 1936 to 1941 inclusive are shown in figure 1. The number of fires and the area burned in each of the four land use districts from 1936 to 1941 inclusive are shown in table 9. Figure 1 and this table indicate that there were very few fires and a very small burned acreage in the virgin forest district. It is significant that 57 percent of the total number of fires and 95 percent of the total burned acreage occurred in the cut-over district. The farm and forest district had a considerable number of fires but they did not burn over much area. Table 10 shows the number of fires and acreage burned in the different cover and fuel types. It reveals that 54 percent of the total number of fires and 80 percent of the burned acreage occurred in the high hazard type which includes the recent cutovers and burns.

Table 8.--Number of fires and area burned per year in the Clackamas-Marion Counties patrol unit

Year	Number of fires	Area burned (acres)
1941	72	391
1940	115	130
1939	77	558
1938	86	69
1937	54	107
1936	71	7,299
1935	70	5,904
1934	38	418
1933	28	12
1932	152	3,661
1931	78	1,930
1930	52	853
1929	105	31,683
1928	55	2,747
1927	18	180
1926	50	479
1925	63	1,529
1924	180	6,878
1923	64	1,776
1922	84	5,260
1921	67	1,414

The data for 1921 to 1932 and 1935 are taken from the State Forester's annual reports and probably include some fires on private lands inside national forest protection boundaries.

Table 9.--Number of fires and area burned in different land use districts, 1936-41, in the Clackamas-Marion patrol unit

Land use district	Distribution of fires		Area burned 1/	
	Number	Percent	Acres	Percent
Virgin forest	27	6	75	0.9
Cut-over	271	57	8,135	95.1
Farm and forest	144	30	316	3.7
Agricultural	33	7	28	.3
All districts	475	100	8,554	100.0

1/ Includes only fires one acre or larger.

Table 10.--Number of fires and area burned in different cover types, 1936-41, in the Clackamas-Marion patrol unit

Cover type	Distribution of fires		Area burned 1/	
	Number	Percent	Acres	Percent
Low hazard	146	31	1,656	19.4
High hazard	257	54	6,863	80.2
Agricultural	72	15	35	.4
All cover types	475	100	8,554	100.0

1/ Includes only fires one acre or larger.

An analysis of fire occurrence is not complete without studying causes and fire occurrence by months. These analyses are shown in tables 11 and 12. An exceptional period of dangerous fire weather in November 1936 upset the symmetry of the fire occurrence and burned acreage figures by months. Dangerous fire weather occurred in February and March in 1941. However, these facts very strikingly illustrate that the length, intensity, and time of the fire season vary greatly from year to year. The tables indicate that it is necessary for the fire control agency to be prepared to cope with dangerous conditions at any time from February to November.

Table 11.--Number of reported fires by cause and month in the Clackamas-Marion patrol unit, 1936-41

Month	Cause									
	Light-ning	Incen-diary	Camp-ers	Smok-ers	Brush burning	Slash-ing	Logging	Rail-road	Miscel-laneous	All causes
	Number of fires									
February	0	1	0	0	0	0	0	0	0	1
March	0	3	0	2	4	0	0	0	1	10
April	0	4	0	1	9	2	0	0	1	17
May	7	4	1	3	12	2	0	1	1	31
June	1	4	2	12	7	2	4	0	3	35
July	69	5	7	17	16	0	6	0	11	131
August	13	5	10	30	44	1	5	0	17	125
September	20	6	4	3	42	1/ 5	1	0	4	85
October	0	0	1	1	1/ 9	1/ 2	0	0	0	1/ 13
November	0	1/ 13	0	0	1/ 11	1/ 2	1/ 1	0	0	1/ 27
Total	110	45	25	69	154	16	17	1	38	475

1/ Principally 1936.

Because most of the fire damage is caused by a few large fires, size of fire by causes (table 13) may be a more significant item to study than number of fires by cause. Table 13 indicates that incendiary, brush burning, slashing and logging fires have produced most of the fires over 10 acres in size. Since brush burning is subject to regulation by permit and in other ways it should be possible to prevent most of the fires attributed to this cause. Although lightning, campers and smokers each cause large numbers of fires very few fires from these causes attain much size.

Conventional "Fires" Do Not Tell Entire Story

Even casual observation indicates that there are many fires in the months before and after the main fire season that are not included in the conventional fire records. Under the Oregon law there is an "open season" and a "closed season" for burning. During the open season, which extends from the time in the fall that the fire season is terminated by the Governor upon the recommendation of the State Forester until May 15, anyone may set fires and do such burning on his own property as he desires without obtaining a permit or meeting any requirement except that of confining the fire to his own lands. Therefore during this open season the fire control agency pays very little attention to intentional or accidental fires unless they receive a call for help or it appears that a fire threatens to destroy valuable property. Only those open season fires which become the concern of the fire control agency to the extent that they spend time or money on them are reported and enter into the forest fire statistics. Open season fires on forest lands can make seedlings, saplings, and old trees just as dead as closed season fires and therefore they merit a place in any complete forest fire statistics used to indicate the total amount of depletion due to fire.

There are inconsistencies in the present fire records. If a fire in a cleared pasture in August threatens forest land and is put out by the warden it is a reportable fire and becomes a part of the forest fire statistics even though no forest land was burned. The fact that forest land may have been threatened by such a fire might be reason enough for including it among the "number" of fires fought, but the area of pasture burned does not cause any depletion of forest resources and there is no valid reason for including its acreage with the forest land acreage burned by forest fires. At the other extreme, a fire which burns in the open season and damages real forest land may not get into the forest fire statistics.

These remarks about fire records are made to call attention to the need for clear-cut definitions of a forest fire and for forest fire statistics which will tell a complete story about the depleting effect of fire upon the forest resource. Some of the present cloudy inconsistencies spring from the lack of sharp distinctions between forest lands and other lands, principally those used for agriculture. The forest land definition quoted in the Introduction is stated in terms of cover conditions and not in terms of land use. Pastures and other types of lands that may be dedicated to agricultural use to the exclusion of all else may have sufficient "forest debris" on them to be classed as "forest land" under this definition. This starts the confusion. How can a fire

Table 12.--Area burned by reported fires one acre and larger by cause and month in the Clackamas-Marion patrol unit, 1936-41

Month	Cause									
	Light-ning	Incen-diary	Camp-ers	Smok-ers	Brush burning	Slash-ing	Logging	Rail-road	Miscel-laneous	All causes
	Area burned (acres)									
February	0	55	0	0	0	0	0	0	0	55
March	0	15	0	3	32	0	0	0	0	50
April	0	134	0	2	93	0	0	0	50	279
May	0	19	10	1	30	2	0	15	0	77
June	0	7	2	17	3	0	40	0	0	69
July	53	121	3	6	0	0	205	0	9	397
August	0	379	0	18	48	0	0	0	20	465
September	0	13	0	0	52	1/830	0	0	0	1/895
October	0	0	0	0	1/10	1/285	0	0	0	1/295
November	0	1/1,179	0	0	1/1,103	1/3,655	1/35	0	0	1/5,972
Total	53	1,922	15	47	1,371	1/4,772	280	15	79	8,554

1/ Principally 1936.

Table 13.--Distribution of causes of reported fires by size classes in the Clackamas-Marion patrol unit, 1936-41

Cause	Total number of fires	Size of fire		
		A - Under 1/4 acre	B - 1/4 to 10 acres	C - Over 10 acres
		Percent	Percent	Percent
Lightning	110	90	9	1
Incendiary	45	20	44	36
Campers	25	64	36	0
Smokers	69	58	41	1
Brush burning	154	51	43	6
Slashing	16	38	31	31
Logging	17	47	29	24
Railroad	1	0	0	100
Miscellaneous	38	74	23	3
All causes	475	60	32	8

in a pasture that is used only for that purpose be a forest fire? A fire in a pasture full of young trees might kill all the trees and not cause any depletion of forest resources provided the owner had no intention of allowing the trees to mature.

However, these statements must not lead to the conclusion that the forest fire control agency should limit its action to forest lands. Within a forest fire control unit such as the Clackamas-Marion patrol unit it is efficient to have only one fire control agency and it must of necessity be responsible for all fire control action on all lands because all fires threaten all lands. Forest lands and other lands are so intimately related that the fire control agency cannot be successful if it takes one kind of action on forest lands and another kind of action or no action on other lands. But it would be feasible and desirable to distinguish in the fire records (and in the cost records) between the fires that burn on forest lands and those that burn on other lands. However, before this can be done it will be necessary to have a clear and generally accepted definition of forest land and maps showing its location.

Fire Occurrence as Related to Roads

Most of the fire reports indicate the distance from the point of origin of the fire to a road. When these records for the man-caused fires were analyzed they revealed that 50 percent of the man-caused fires started within 100 feet of a road, that 95 percent started within 1/4 mile of a road, and that 100 percent started within one mile of a road. These figures follow the pattern of similar studies in other areas. This pattern of distribution is to be expected because the habitations, fields, logging, sawmilling and woodcutting operations and recreational attractions where most of the people live or work or play are almost invariably on roads. The fact that almost all of the man-caused fires can be readily reached from roads should be used in planning fire control facilities. For example, tank trucks with about a quarter mile of hose could have reached the starting point of about 95 percent of all the man-caused fires in the Clackamas-Marion patrol unit. Patrol along roads should be effective in preventing, finding and controlling man-caused fires. Local residents and the traveling public should be able to see and report many fires. The fact that so many fires occur within 100 feet of a road indicates that hazard reduction and other fire prevention measures should be concentrated along roads.

Relation of Burning Rates to Forest Management

Tables 14 and 15 have been prepared to show fire occurrence and burning rates in the four land use districts and in the low hazard and high hazard cover and fuel types on a strictly comparable basis by computing rates per 100,000 acres. This is a desirable method of making comparisons because it eliminates differences due to varying acreages. For example, table 14 indicates that the virgin forest district has 5 fires, the cut-over district 15 fires, the farm and forest district 21 fires, and the agricultural district 19 fires per 100,000 acres per year. This immediately reveals the true intensity of fire occurrence

Table 14.--Number of fires per year per 100,000 acres of each forest[1] cover type within each land use district in the Clackamas-Marion patrol unit, 1936-41

Cover types	Land use districts				
	Virgin forest	Cut-over	Farm and forest	Agricultural	All districts
	Number of fires				
Low hazard forest types	4	9	15	5	9
High hazard forest types	32	22	26	26	23
Average, all forest types	5	15	21	19	14

1/ In addition there were 8 fires per 100,000 acres of agricultural cover types.

Table 15.--Area burned per year per 100,000 acres of each forest[1] cover type within each land use district in Clackamas-Marion patrol unit, 1936-41

Cover types	Land use districts				
	Virgin forest	Cut-over	Farm and forest	Agricultural	All districts
	Area burned (acres)				
Low hazard forest types	9	175	10	0	97
High hazard forest types	161	800	117	7	616
Average, all forest types	14	472	59	5	303

1/ In addition there were 4 acres burned per year per 100,000 acres of the agricultural cover types.

per unit of area and reveals that although the cut-over district, which is relatively large, had 57 percent of the total number of fires, the farm and forest district, a relatively small district with 21 fires per 100,000 acres per year, has the highest occurrence rate for a comparable area. Table 15 shows that the high hazard cover types have a burning rate that is six times that of the low hazard cover types (616 acres per 100,000 acres per year compared to 97). It also shows that the burning rate of 472 acres per 100,000 acres per year (almost 1/2 of 1 percent) in the cut-over district far exceeds the rate in any other district.

It has long been the goal of forest management in the Douglas-fir region to hold the loss from fire to 1/4 of 1 percent per year figured on an acreage basis. The burning rate in the Clackamas-Marion patrol unit during the 21-year period 1921 to 1941 inclusive was about 3/4 of 1 percent, which is too high to be acceptable. During the recent 6-year period 1936-41 inclusive the burning rate has been only about 3/10 of 1 percent, which is nearly as low as the above goal. Experience indicates, however, that in order to attain a burning rate of 1/4 of 1 percent over a long period, for example 50 years, the rate most of the time should be much lower in order to absorb the bad years and catastrophes that may account for at least half of the loss over a long period of years. Therefore it would seem necessary to strive for a burning rate of much less than 1/4 of 1 percent in the Clackamas-Marion patrol unit in order to absorb the large fires that may happen at long intervals.

Furthermore it is not believed that the figures in table 15 indicate the total burning rate or fire depletion in any of the land use districts, with the possible exception of the virgin forest district, because this table is based on reportable fires only and takes no account of the considerable area burned over per year by nonreportable fires and permitted fires. The conventional fire records used in making table 15 do not reveal the total effect of fire on the forest lands for forest management purposes because they do not include all the acreage of forest land that is burned. There are annually in the Clackamas-Marion patrol unit several thousand permit fires that all told burn over several times as many acres as the reported fires. There are also open season fires in addition to the permit fires. Obviously some, not all, of these fires have an impact upon forest cover that is just as important to future growth and yield as if they were reportable. In order to determine the true burning rate or depletion due to fire on forest land in the Clackamas-Marion patrol unit or any similar unit in Washington or Oregon it will be necessary to gather data on all fires that affect forest land.

There are several ways in which forest land owners would benefit from the attainment of high specifications of adequate fire control. The effect upon the preservation of merchantable timber and the security of investments therein is obvious. The attainment of low burning rates on cut-over or burned forest lands would have far-reaching effects not so readily apparent. On these lands repeated fires tend to retard reforestation, lengthen the rotation, reduce the quality and quantity of the future crop, and make forestry a

risky undertaking. Adequate fire control on a high level would tend to speed up reforestation, shorten the rotation, improve the quality and quantity of the future crop, and make forestry a safer undertaking. Therefore it may be wiser to spend 10 or 15 cents per acre per year for fire control on reforesting lands because of the results that could be obtained than to go on spending the present 4 or 5 cents. Some of the possibilities in this direction have been developed by Hoffman.5/

Since forest fire control is a tool of forest management and not an end in itself it follows that it is the responsibility of forest land owners to demand adequate fire control and to write its specifications. Every indifferent landowner who does not have specific plans for the future management of his forest land tends to weaken fire control and every landowner who has definite plans for the future management of his lands, which of necessity must include positive fire control, tends to strengthen fire control. Therefore better fire control in the Clackamas-Marion patrol unit or any similar area must come from the demands of the forest land managers, public and private. The soundest way to promote better fire control is to promote better forest management.

ADMINISTRATION OF FIRE CONTROL

Organization and Personnel

In 1940 the field organization in the Clackamas-Marion patrol unit consisted of the district warden in charge, one dispatcher, one truck and pump man, two firemen, one patrolman-packer, six lookouts, six patrolmen, three guards and one full-time and one part-time inspector. This regular force of 23 men is about the usual number employed during the period studied, 1936 to 1941 inclusive. During several fire seasons, in addition to the regular force, a standby crew of 5 CCC men was kept at the headquarters. The warden and one inspector are employed yearlong. The other men are employed for varying periods of from three to six months. In 1941 the war emergency Cooperative Forest Fire Control program financed with Federal funds handled similarly to Clarke-McNary funds provided 27 men for three stand-by crews and five one-man positions in addition to the regular force. These additional men were used to give extra protection to areas important to national defense.

As indicated in table 16, the Clackamas-Marion patrol unit with 5.6 men per 100,000 acres has more men on duty during the fire season per unit of area than any other Association in western Oregon. The Clackamas River Ranger District of the Mount Hood National Forest, which borders the Clackamas-Marion patrol unit on the east, has slightly more men per unit of area for a very different type of area, being relatively undeveloped and uninhabited. The Snohomish County unit in Washington, the sample area that was the subject of a previous study by the authors, had less men per 100,000 acres. These comparisons are chiefly valuable to give a general idea of the intensity of manning on the Clackamas-Marion patrol unit. They do not, of course, tell the whole story. To do that it would be necessary to give weight to such items as the quality of men and their training and

5/ Hoffman, Bruce. Management possibilities in Douglas fir forests. 45 p. Washington. 1941.

experience, volume of fire protection business, transportation facilities--roads and trails--and fuel types. The amount of detection and other services given to or received from adjoining areas is also important but has not been taken into account in making the above comparisons.

Table 16.--Comparison of the number of fire control employees per 100,000 acres in various units in Oregon and Washington

Unit	Acres protected	Employees	Men per 100,000 acres
Clackamas-Marion	519,000	29	5.6
Coos	1,066,000	35	3.5
Douglas	1,385,000	36	2.6
Eastern Lane	650,000	15	2.3
Lincoln	473,000	11	2.3
Linn	552,000	23	4.2
Northwest Oregon	1,644,000	78	4.8
Polk	287,000	13	4.5
Western Lane	724,000	20	2.8
Snohomish County, Washington	546,000	20	3.7
Clackamas River District, Mount Hood National Forest	279,000	19	6.8

Division of Responsibility for Fire Control

Fire control on all forest lands of several ownership classes--Association, tax roll, State, county, revested Oregon and California railroad grant land, public domain, and national forest--within the patrol boundaries of this unit is the responsibility of the Clackamas-Marion Counties Fire Patrol Association. This is confirmed by the following statement in the State Forester's Annual Report for 1938 (page 30):

> "It is clearly brought out in this discussion that responsibility for protection in association units is not with the state forestry department but rests with the association directors. These officials approve the annual budget, authorize expenditures, employ the seasonal field personnel and conduct all field work in connection with forest patrol and fire suppression."

The State contracts with the Association for the protection of tax roll, State, county and national forest lands within Association protection boundaries for which the State is responsible. The limitations of this delegation of responsibility are well stated in the following paragraph,

also from the State Forester's Annual Report for 1938 (page 30):

> "Any form of contract dealing with protection cannot be too restrictive, since forest protection involves many matters of opinion such as the determination of adequate protection, the degree of the fire hazard, the size and seasonal duration of the protective force, methods of patrol and fire suppression and similar matters. The authority to make decisions under such conditions must be included in the contract and this has been done by the state. It is only under extreme and unusual situations that the state forestry department may relieve the associations of their responsibility. This would apply only where there is obvious inefficiency in carrying out the protective work or where a breakdown has occurred due to extreme conditions such as might arise during a fire which reached the conflagration stage."

Although the State delegates its "patrol and fire suppression" activities to the Association it retains its law enforcement responsibilities. The inspectors who issue operating permits and inspect operations to enforce State laws pertaining to them are State officers paid by the State and working under the direct supervision of the State Forester. But the inspectors are not responsible for the adequacy of the protection given by the Association under its contract with the State. The head warden of the unit is paid in part by the State and is responsible to and directed by the State Forester in enforcing certain forest laws, mainly those having to do with burning permits, closures, trespass, and prevention. But he is also at the same time an employee of the Association.

The present division of responsibilities between the State and the Association is not a static thing nor did it come about all at once or by any special design. Rather it is but one stage in an evolutionary process which it is believed is tending toward adequate protection for all forest lands of all ownerships. This subject seems so important to the future of fire control in the Clackamas-Marion patrol unit and to other forest lands in Oregon that it seems worth-while to trace the evolutionary process which has brought it to its present status.

The State Forester's Annual Reports contain many statements, some of which will be quoted here, that show the evolution of forest protection in the Clackamas-Marion patrol unit and in Oregon. In reading these statements it should be remembered that before about 1910 timber owners in Oregon protected their own lands from fire and there was no other form of protection. Protection started on a voluntary basis and only a comparative few gave their lands any protection.

The following statements quoted from the State Forester's Report for 1912 (pages 33-35) tell how the Associations came to be formed:

> "The records of expenses per acre 1911 showed the cost of maintaining patrol through the three organizations (associations) less than one-half that paid out by owners maintaining individual patrols and the loss of timber was smaller in the association patrolled territory than elsewhere . . . The two systems of patrol

had been thoroughly tried out in both Idaho and Washington and private effort abandoned because of its cost and inability to show good results.

"Immediately following the season of 1911 it was therefore decided to take up the work of increasing the local patrol association's activities. The plan received the endorsement of the State Board of Forestry, was actively entered into by the Oregon Forest Fire Association and the State Forester, these two agencies joining hands to advance the movement.

"It was decided for purposes of convenience to organize patrol associations by counties, and in order to stimulate greater interest, the State offered to hire jointly with timber owners the head wardens for districts which organized, and to employ in addition to this such other patrolmen as good policy demanded and funds allowed of. By this plan patrols covering six additional counties were formed making ten counties so covered in the State and in every case good work was performed."

Also consider this significant statement about placement of responsibility from the State Forester's Report of 1911 (page 10) quoting letter of instructions to the wardens:

"It is not the intention of the forest fire laws that the State should be called upon to fight forest fires, and there is no appropriation made for that purpose except in extreme emergencies. The real intent of the law, however, is to prevent fires and, in case fire does get started, to see that the proper persons (that is, those who are the most interested in the locality of the fire, whether timber owners, sawmill men, loggers, farmers or others) do get an adequate force of men on the ground immediately to properly handle and extinguish the fire."

But Association protection had one major weakness. From the State Forester's Report of 1914 (page 33):

"However, the greatest weakness in connection with the association work was that the contributing acreage constituted too small a proportion of the total area patrolled, or in other words, there was a large area of timber land protected by the association which did not pay its proportionate share of the cost of such protection."

Oregon's compulsory patrol law of 1913 was enacted to overcome this weakness. It was the first in the United States. The following statement indicates that the patrol law was used to strengthen the Associations instead of being used to strengthen State protection:

"The State Board of Forestry considered it inadvisable to provide actual patrol for privately owned timber land except as a last resort and the (compulsory patrol) law was therefore used to persuade heretofore indifferent owners to join patrol associations in counties covered by such organizations and to stimulate new

associations in counties where none existed. Chiefly due to the above law, six new associations were formed in 1913, while membership in the old associations was more than doubled."

Consider also the following from the same report (referring to compulsory patrol law):

"Acting under authority conferred by the law, the State Forester, during the seasons of 1913 and 1914 provided patrol for all timber land whose owners failed to furnish the same. In counties where associations existed such lands were turned over to these organizations for patrol, while in other counties similar arrangements were made with companies or individuals having extensive holdings and who were maintaining a private patrol."

Cooperation was the key word in forest protection for many years. Consider these significant statements from the State Forester's Report of 1914 (page 16):

"That State assistance has stimulated co-operation among owners is unquestioned, and that such assistance has resulted in far greater effort on the part of private interests is strikingly shown in the following comparative statement:

Fire Protection Expenditures - 1911-1914

	1911	1912	1913	1914
State	$11,323.27	$13,301.51	$16,548.36	$ 17,695.06
Timber land owners	45,790.00	46,016.68	71,025.47	140,006.18

". . . The private owners have by far the largest force of wardens in the field and in association counties assume responsibility for fire fighting. This relieves the State Board of Forestry of a great burden and makes it possible for them to devote a large part of their efforts toward effective prevention measures. The State's participation in the protection work and the hiring jointly of the supervising warden . . . lends strength to the private owner's work."

From State Forester's Report of 1920 (page 28), speaking of the compulsory forest protection law of Oregon:

"The principle of the Oregon law is based wholly on the police power of the State. It is neither taxation or insurance and does not recognize the value of the property involved. It rests solely on the premise that the individual may not maintain a menace to the life, property, or legitimate enterprises of others and that such a menace exists in unprotected land from which fire may spread. He is, therefore, required to provide adequate protection. If he does not, the state may provide it and make him pay the cost it has thus been obliged to incur to protect its citizens from the illegal danger for which he is responsible."

But in most cases the State does not furnish this protection direct--it contracts with an Association. The following about the formation of the Clackamas-Marion Counties Fire Patrol Association is quoted from the State Forester's Report for 1912 (page 39):

> "Covering two counties as the name indicates this patrol though started late in 1912 has shown markedly the good results of cooperative effort. The territory prior to 1912 was never patrolled in any systematic manner and serious fire losses occurred.
>
> "Fourteen companies or individuals joined in the expenses of the patrol for 1912 and not only was there no loss of timber but the assessment was kept down to one cent per acre . . .
>
> "Over 400,000 acres of timber was patrolled by eight men and a head warden. No assistance was secured from the county but the state through its funds and those furnished under the Weeks law paid the head warden and part of the salaries of several other wardens."

The above quotations show that during the early years of forest protection the people did not organize a strong centralized State fire control agency but instead they organized private Associations to carry on most of the fire control activities and in the first fire laws they made landowners and operators responsible for fire control on their own forest lands or operations.

Although the early trend of forest protection in Oregon was toward the development of Associations and individual responsibility the later trend, as revealed by the decreasing Association acreage and the increasing tax roll acreage in table 17, is toward greater public responsibility. Association acreage in 1915 far exceeded the tax roll acreage in the Clackamas-Marion patrol unit and in the entire State. But from about that time until the present the Association acreage has been gradually decreasing as the timber was cut while the tax roll acreage has increased manyfold and the total area patrolled has also increased. In 1940 the Association acreage in the Clackamas-Marion patrol unit represented only 21 percent of the total lands patrolled and was less than half as large as the tax roll acreage. The relationship for the State as a whole is quite similar. Tax roll acreage made a marked increase in 1941 because of the repeal of residence exemption. It is doubtful if the repeal of residence exemption will have any effect upon Association acreage. In addition the membership of 30 owners constituting the Clackamas-Marion Association is small compared to the 3,500 owners having tax roll acreage.

In conclusion, it is appreciated that forest fire protection in Oregon achieved remarkable success as a cooperative enterprise shared in by the private owner, the Associations of private owners, and the State. But conditions are changing, Association acreage is decreasing, tax roll acreage is increasing, and it is a direct responsibility of the State to obtain adequate protection for tax roll land. There are also considerable acreages of Federal, State, county and other forest lands to be protected. The trend is unmistakably toward greater public responsibility in forest

fire control. If this trend continues the State will probably have a greater direct share in providing adequate fire control for all forest lands. The Associations have demonstrated the advantages of cooperation in fire control. But fire control to be successful in a highly developed community must be applied to all lands without exception. This need for complete coverage made the Associations more successful than private patrol and it may be one factor which will make the State, which is in effect an all-inclusive cooperative, assume greater direct responsibility for fire control on all forest lands.

Table 17.--Trend of Association acreage, tax roll acreage, and total area patrolled in Clackamas and Marion Counties and the State of Oregon, as shown by the State Forester's annual reports

Year	Association acreage	Tax roll acreage	Total acreage patrolled
Clackamas-Marion Counties[1]			
1915	141,874	30,894	250,786
1920	135,125	50,838	-
1925	136,419	124,132	-
1930	117,395	147,002	355,596
1935	105,367	232,054	426,461
1940	106,372	[2]236,562	514,350
State of Oregon			
1915	3,597,262	2,419,795	8,669,155
1920	3,163,977	-	-
1925	3,391,823	2,381,276	-
1930	3,393,714	5,188,197	11,315,300
1935	3,039,937	6,415,639	12,094,851
1940	2,884,483	5,797,713	12,426,105

1/ Figures include private lands inside the national forest protection boundaries.
2/ 1941 tax roll listed 284,600 acres after residence exemption was abolished.

ANALYSIS OF FIRE CONTROL ACTION

Detection

There are six Association lookouts in the Clackamas-Marion patrol unit, several national forest lookouts adjacent to the unit, and one lookout in a nearby patrol unit that can see parts of the area. Study of the fire reports for the six years 1936 to 1941 inclusive reveals that these lookouts discover about one-third of the fires of all causes, other Association employees discover less than one-third and others not connected

with the Association discover somewhat more than one-third: 33, 29, and 38 percent, respectively. The results follow this pattern consistently whether the discoveries are tallied by land use districts, pre- and post-season versus midseason, or by size of fire. Considering lightning fires separately the lookouts discover a slightly lower percentage, 30 percent, other Association employees 27 percent, and others 43 percent. The fact that farmers, travelers, housewives and others who constitute the public discover more than a third of all fires and 43 percent of the lightning fires is a very significant consideration in determining how to improve the detection of all fires.

Although lookouts are usually deemed especially valuable in the detection of lightning fires the above records and especially those for 1941 indicate that poor visibility or other factors may at times put them at a disadvantage. Of the 42 lightning fires in 1941, most of which resulted from one mid-July storm, only 12 percent were discovered first by lookouts, 33 percent were discovered by other Association employees, and 55 percent were discovered by the public.

Speed of Attack

Table 18 shows the number of fires discovered by lookouts, others connected with the Association, and the public by discovery-to-start-of-work elapsed time classes. More of the fires discovered by others connected with the Association or the public fall into the 0- to 15-minute class than the lookout-discovered fires. This is because these other discoverers in many cases are close to the fire before they see it and start to work immediately, while a lookout, being stationary on a vantage point, seldom discovers a fire that he can get to in 15 minutes. This table also shows that work starts on 62 percent of all fires within one hour after they are discovered and on only 3 percent of all fires does more than 24 hours elapse from discovery to start of work.

Table 18.--Elapsed time from discovery to start of work tabulated by discovery agencies. Man-caused and lightning fires, Clackamas-Marion patrol unit, 1936-41

Time	Discovery agency							
	Association lookout		Other Association		Public		All	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
0 - 15 min.	15	11	58	42	63	35	136	30
16 - 30 min.	23	17	17	12	23	13	63	14
31 - 60 min.	28	20	25	18	30	16	83	18
1+ - 2 hr.	22	16	10	7	23	13	55	12
2+ - 6 hr.	28	20	16	12	22	12	66	14
6+ - 24 hr.	13	10	12	8	16	9	41	9
Over 24 hours	8	6	1	1	4	2	13	3
Total	137	100	139	100	181	100	457	100

Responsibility for Action on Fires and Who Does the Work?

Table 19 indicates that the Association did the major amount of suppression work on half the fires which occurred within its territory from 1937 to 1941 inclusive and that "others", principally operators and residents, did the major amount of work on the other half. Under Oregon's forest fire laws loggers, woodcutters, land clearers, or right-of-way clearers are responsible for the suppression of all fires in their operating area even if they are in no way responsible for the start of the fire. Those who claimed residence exemption were also required to fight all fires on their exempted lands and recipients of burning permits are required to put out their fires if they get beyond control. The Association is directly responsible for fire control action on lands of its members and the tax roll and other lands which have been contracted to it providing such lands are not in an operating status. This indicates the legal basis for having some fires fought principally by the Association and some fought principally by others.

Table 19.--Percentage of fires upon which major work was done by Association employees and by others tabulated by land use districts in the Clackamas-Marion patrol unit, 1937-41

District	Association employees	Others	Total	
	Percent	Percent	Percent	Number
Virgin forest	76	24	100	21
Cut-over or burned	62	38	100	217
Farm and forest	34	66	100	130
Agricultural	16	84	100	32
All districts	50	50	100	400

It is the policy of the warden to go to every fire that is reported. If the Association is not responsible for action on the fire his job is to get the responsible party to take action. Even where someone else is clearly responsible for action the Association man or men usually help suppress the fire, but if extra help must be hired the one legally responsible for the fire must pay the cost. In the case of small fires the question of responsibility may not arise and the first man to get to it will put it under control. It sometimes happens that fires for whose suppression the Association is responsible are found and controlled by people who are not employed by the Association. In studying the records of 394 fires from 1937 to 1941 which had the necessary information there was found to be the following relationship between responsibility and fire suppression action:

Association responsible for suppression and did major amount of work - 32 percent of fires.

Association responsible for suppression but others did major amount of work - - - - - - - - - - - - - - - - - - - 2 percent of fires.

Others responsible for suppression and did major amount of work - 48 percent of fires.

Others responsible for suppression but Association did major amount of work - - - - - - - - - - - - - - - - - - - 18 percent of fires.

100 percent.

With the above explanation it is not surprising that table 19 shows that the Association did the major amount of work on 76 percent of the fires in the virgin forest district or on 62 percent of the fires in the cut-over district and on only 34 and 16 percent of the fires in the farm and forest and agricultural districts, respectively. These figures reflect the marked differences in the land ownership, land use, activities of people and resultant division of responsibility for fire control in the four land use districts. They demonstrate that the Association has a somewhat different role in each district with regard to fire suppression. It is the dominant fire suppression agency in the virgin forest district but it is progressively much less dominant in the other three districts.

Since it is the policy of the Association to report as a fire only those fires visited or acted upon by an Association employee, the records used as the basis for the above analysis do not include all fires put out by "others." Landowners, woods operators, and others undoubtedly extinguish fires which for one reason or another are not reported to the warden. Therefore the records contain all the fires acted upon by the Association but they do not contain all the fires acted upon by others. This is according to accepted practice. The statement is made, however, to indicate that persons outside the Association have even a greater part in fire suppression in the patrol unit, especially in the more settled part of it, than is indicated by the fire records.

It is interesting to compare the responsibility of a city fire department and that of the Association. The city fire department is responsible for extinguishing any and all fires on all properties within its territory. Anything that the property owner may do in the way of providing a sprinkler system or other fire protection is additional, supplemental protection, but it does not relieve the city fire department of its responsibility. Even though a citizen may have a fire in a high hazard which he has on his own property or may start a fire by his own carelessness or intent he is not required to control the fire after the city firemen arrive. They do not require the careless smoker who starts a fire in his davenport to put out his fire or pay the cost. Out on forest land very different customs and practices have developed. The landowner is expected and required to control fires that occur on his lands under certain conditions and this in spite of the fact that few landowners may have the ability,

manpower, equipment or other resources needed to take the prompt, strong action needed on forest fires. One of the principal present duties of the fire wardens is to see to it that the responsible party takes proper action. Under the law the fire control agency is not supposed to control certain fires unless the responsible party fails to meet his responsibility.

It is granted that under the pioneer conditions in which forest fire laws developed fire protection in the forest was quite different than in a city. However, as forest land becomes more intensively managed and intermingled with human use and habitation the differences tend to disappear and there is a growing need for some one agency to take prompt, strong action on all fires on all forest lands and other properties associated with them.

ANALYSIS OF COSTS AND FINANCIAL SUPPORT

What Does Present Fire Control Cost?

The total State and Association expenditures were found to be about $25,000 per year based on 1940 and an inspection of the records of 1938, 1939, and 1941. The $25,000 does not include any money spent by landowners or operators except what they pay as Association dues or patrol assessments. Landowners and operators spend a considerable amount of money that is directly or indirectly for fire control for such items as slash disposal, snag falling, fire suppression, and watchmen, but it is not a matter of record and could not be included here. Neither was it practicable to include even an estimate of the value of the CCC contribution to fire control in the patrol unit. Therefore the $25,000 annual cost mentioned above represents the direct cost to the protection agencies only. Spreading this cost over the 468,000 acres of forest land in the unit indicates a direct cost of about 5.3 cents per acre.

Where Does the Money Come From?

Table 20 indicates the source of the money used to pay the fire control costs in the Clackamas-Marion patrol unit. Association members pay only 17 percent of the total cost. It shows that about 47 percent of the total cost is paid by the landowners as Association or tax roll assessments. The assessment rate was 4 cents per acre in 1940. Federal Clarke-McNary funds pay over one-fourth of the cost. The State pays about 16 percent of the total cost. The Association disburses three-fourths of all the money spent in the unit.

It should be mentioned again that because of the CCC contribution the Federal share of the complete cost of fire control was much greater than is indicated in table 20.

Table 20.--Source of $25,000 spent on fire control, Clackamas-Marion patrol unit, 1940

Source	Percentage of total
Association assessments	17
Tax roll assessments	30
Federal funds	
Clarke-McNary	27
For protection of O & C and public domain lands	9
State funds	1/16
County funds for protection of county lands	1
Total	100

1/ Includes 1 percent paid to the Association for the protection of State land.

How Is the Money Spent?

The distribution of fire control costs is shown in table 21. The first item includes the wages and expenses of all Association and State employees in the unit. The State's share of this cost covers the salaries and expenses of the State inspectors and the State's share of the warden's salary. The table indicates that fire fighting costs were very low during the year used as a base and they were also low in 1938, 1939 and 1941. This is, of course, the one item in the table which might show considerable variation from year to year. The item "Central control fund" covers the cost of this unit's participation in the insurance fund which pays fire suppression costs beyond a fixed amount thereby tending to level off these costs and stabilize the cost of fire control as reflected in the annual assessments against the property protected. The table indicates that administration and overhead items absorb 19 percent of the total fire control cost. This large item for administration and overhead suggests the possibility that there may be some duplication of activities between the State and the Association.

Table 21.--Distribution of $25,000 spent on fire control, Clackamas-Marion patrol unit, 1940

Item	Percentage of total
Field costs	
Wages and expenses except fire fighting	66
Fire fighting wages and expenses	1
Improvements, tools, etc.	5
Central control fund	9
Administration and overhead	
Association	8
State	1/11
Total	100

1/ This unit's share of total State fire control overhead prorated on an acreage basis.

CONCLUSIONS AND RECOMMENDATIONS BASED ON THE ANALYSIS

1. During the early years of forest protection in Oregon the people did not organize a strong centralized State fire control agency but instead they organized private Associations to carry on most of the fire control activities and in the first fire laws they made landowners and operators responsible for fire control on their own forest lands or operations (31-34).[6]

2. Forest fire protection in Oregon achieved remarkable success as a cooperative enterprise of the private owners, the Associations of private owners, and the State. But Association acreage is decreasing, tax roll acreage is increasing, and it is a direct responsibility of the State to obtain adequate protection for tax roll land. There are also Federal, State and county forest lands to be protected. The trend is unmistakably toward greater public responsibility in forest fire control. If this trend continues the State will probably have a greater direct share in providing adequate fire control for all forest lands. The Associations demonstrated the advantages of cooperation. The need for complete coverage made the Associations more successful than private patrol and the same need may make the State, which is in effect an all-inclusive cooperative, assume greater direct responsibility for fire control on all forest lands (32-35).

3. To be successful in a highly developed community fire control must be applied to all properties without exception and without delay. Therefore there is a growing need for strong, unified, efficient fire control action on all fires on all forest lands and other properties associated with them (11, 26, 34, 39).

4. Although a high level of forest fire control has already been attained in Clackamas and Marion Counties there are many ways in which it can be improved and strengthened (21-23).

5. As an objective it is suggested that the annual burning rate should be much less than 1/4 of 1 percent. All fires on all forest land at all seasons of the year, except those used for hazard reduction or land clearing, should be included in computing the annual burning rate (24, 28).

6. Present laws that provide the legal basis for organizing fire control outside cities and towns should be strengthened by requiring adequate fire control (11).

7. The total amount of money spent in 1940 by the Association and the State, amounting to 5.3 cents per year per acre of forest land, does not represent the total cost of fire control in this unit because it does not include the large Federal CCC contribution or the large fire control expenditure of private landowners or operators (39).

6/ Numbers refer to the pages in the text where this subject is discussed.

8. Greater consideration should be given to the depleting effect of all fires on forest lands--reportable or nonreportable, open season or closed season, permitted or not permitted--in gathering or using forest fire statistics (24, 28).

9. Although the permit laws are effective fire control devices the objective of preventing fire losses could be more nearly attained if the fire control agency would do more of the actual burning or hazard reduction or provide more of the intensive protection where that is necessary. Permittees should be required and enabled to make advance proof of financial ability to carry out the terms of the permits. Public use of private forest lands should also be regulated under some form of permit as a fire prevention measure (16-18).

10. Fire losses have been held to a low level in recent years. But this fact should not lead to the assumption that higher fire control standards are unnecessary. It is important now to so skillfully plan all fire control activities that a high level of performance will be maintained in spite of war, bad years, and all unfavorable circumstances. It is also necessary to use skill in planning fire control in this unit in order to get the highest possible return from each dollar spent (21-23).

Part II
PLANNING PROCEDURES DEMONSTRATED ON A SAMPLE AREA OF SIX SECTIONS

The first part of this report has described fire occurrence and the economic conditions and forest cover types affecting forest fire control in the Clackamas-Marion patrol unit. The present part will describe the additional steps that are necessary to determine whether present protection facilities such as lookouts, roads, manpower, communications, etc. are adequate to protect the area from fire.

To illustrate the principles and a few of the details of the steps in planning protection facilities a sample area of six sections has been selected for intensive study by means of maps. These maps and discussions on following pages are intended to demonstrate how a fire protection administrator might study his own facilities to determine where additions or adjustments should be made. There is much room for variations in the detailed procedures of planning fire control facilities. Each protection unit may be affected by somewhat different conditions that call for variations in the planning procedures. The general principles of planning to be outlined here will, however, apply to any protection unit and should be included in the procedure of planning facilities for every unit.

ANALYSIS OF NEEDS AND FACILITIES

The first step in planning fire protection facilities for a unit already receiving protection is to determine how well the established facilities meet the needs of the area to be protected. The second step is to determine what additions or adjustments of facilities should be made.

The needs of an area to be protected will be greater or less depending on several factors. The kind of fuel existing on the area is important. Dangerous fuels such as unburned slash, snags, blowdowns, etc. need greater and better protection facilities, other things being equal, than fuels in which fires spread more slowly and which allow rapid fire line construction. The normal fire weather in a given area is important. If the weather is usually dry and windy the area will need better protection facilities than if the weather in that area were damp and calm. The chance that a fire will be set is important. If the area is liable to have many smoker fires it will need better facilities than if it were not exposed to smoker fires.

Fuel Classification

The types of fuels in a given protection unit can be considered most effectively for planning purposes if they are classified according to the danger they present when afire during the kind of weather that occurs on the worst half or one-third of the days of the fire season. That part of the fire control job due to the kind and quantity of fuel will be called the "hazard" in the following discussion. Thus slashings, blowdowns, and areas of numerous snags can be classified as extreme hazards. Cut-over areas in which the slash has been burned and which are

still covered mostly by brush and weeds can be classified as high hazards. Green timber in dense old-growth or large second-growth stands can be classified as low hazards.

The hazards when classified should be outlined on a map of the protection unit. Such a map has many advantages and uses. When recorded in map form careful observations and classification right on the ground are available for future use without depending on the uncertainties of the observer's memory. The information gathered by one man can be passed along to others in map form. When the fuels are classified and entered on maps locations of high hazards can be studied with reference to road maps, maps of areas visible from lookouts, and locations of centers of high risk or active fire starting agencies. All of these factors influence plans for protection facilities and must be studied together. These various factors can best be considered together if they are systematically assembled on maps. This becomes especially important when planning fire control facilities in conjunction with other persons not familiar with the details of conditions in all parts of the fire control unit.

A hazard map for a sample area in Clackamas County is shown in figure 2. The illustration is on a scale of 2 inches per mile to make the detail clear but for practical application a scale of one or one-half inch per mile will be satisfactory. Too small a scale makes accurate fuel type mapping more difficult and decreases the value of some of the maps to be described later. It is recommended that all maps be made on a one-inch scale.

Risk Analysis

In most fire control units fires are more liable to be started in certain localities than in others owing to greater carelessness, greater use of forest land by smokers and campers, more use of fire for land clearing, more incendiarism, more frequent occurrence of lightning storms, etc. The chance or probability that a firebrand will be dropped in a given locality is termed "risk" in the following discussion. Thus "risk" means that part of the chance that fires will occur aside from the kind of fuel, the dryness of the fuel, the kind of weather, etc.

The risk in a fire control unit should be studied systematically so that special plans can be made for the localities of higher than average risk. In order to do this it is necessary to list the localities where the risk is higher than average. A warden who is well acquainted with the activities of people in all parts of his district can probably make a list of these high risk localities with very little difficulty. He will know where the berrypicking, fishing, camping, and picnicking areas attract people who might carelessly set fires. He will also know the localities in which incendiary and land clearing fires are liable to occur.

A map of fire occurrence during the last several years similar to that in figure 1 will probably be useful in listing the high risk areas. The locations of past fires should not, however, be used as a forecast of the locations of the future fires without applying considerable judgment

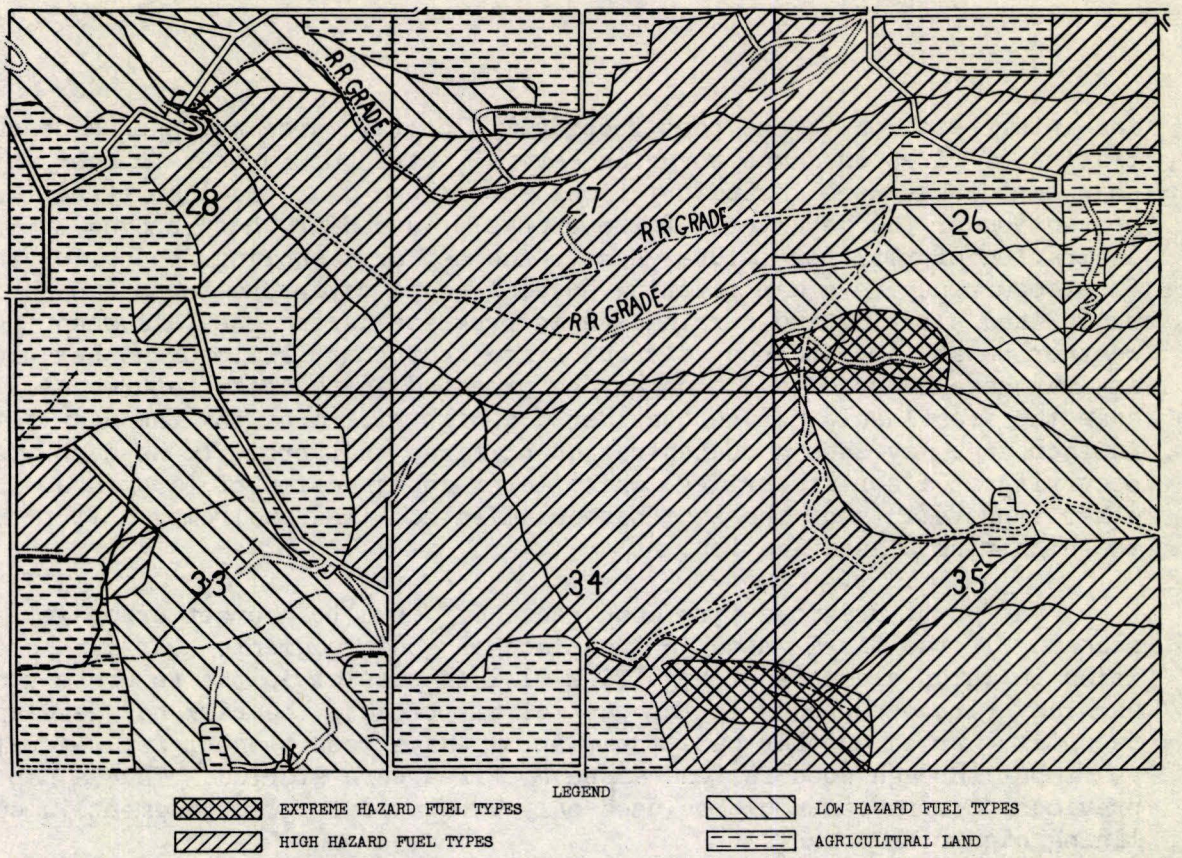


FIGURE 2.--FOREST FIRE FUEL TYPES CLASSIFIED ACCORDING TO THE COMBINED HAZARD OF PROBABLE RATE OF FIRE SPREAD AND PROBABLE DIFFICULTY OF CONTROL UNDER ORDINARY BAD WEATHER CONDITIONS AND AREAS OF AGRICULTURAL LAND IN A SAMPLE AREA OF SIX SECTIONS IN THE CLACKAMAS-MARION PATROL UNIT.

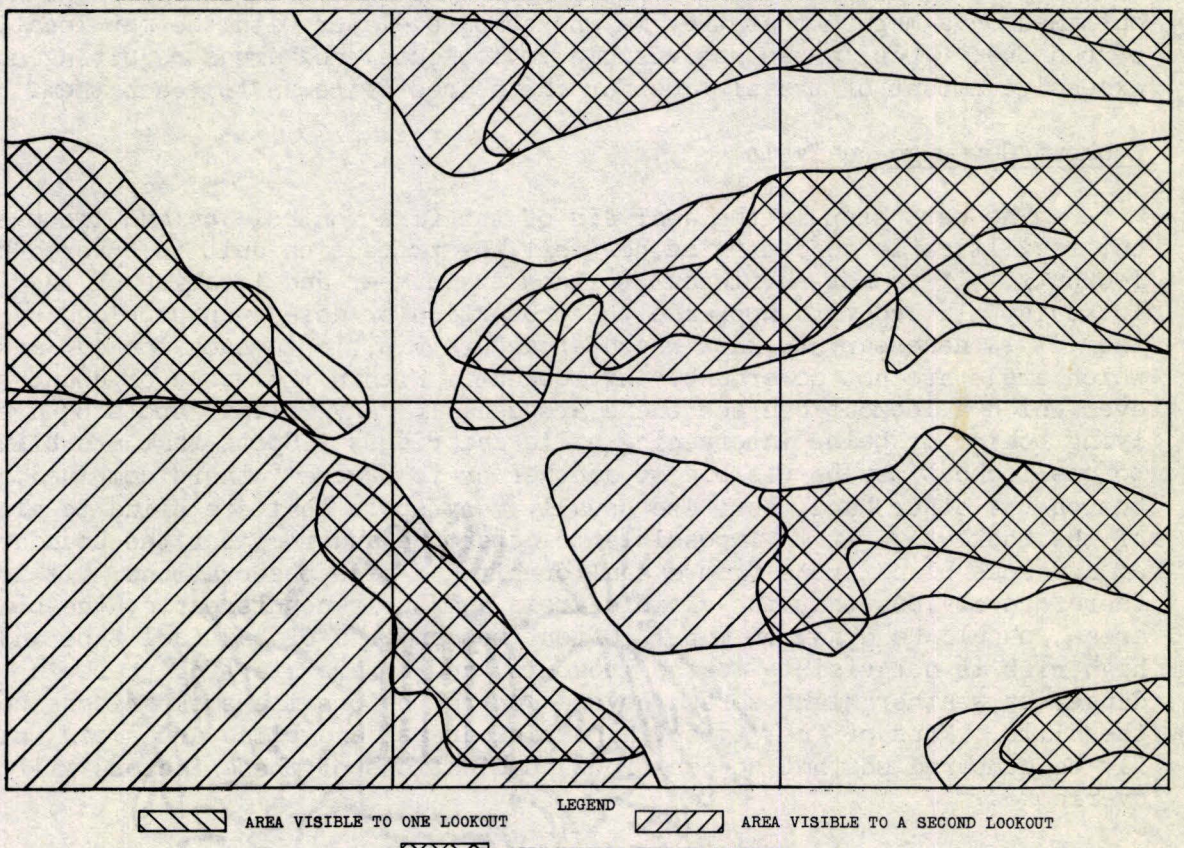


FIGURE 3.--AREAS VISIBLE TO ONE OR MORE ESTABLISHED LOOKOUTS IN THE SAMPLE AREA OF SIX SECTIONS IN THE CLACKAMAS-MARION PATROL UNIT.

and interpretation to the past records. A certain area may show a concentration of fires on a map covering several years but further thought may show that these were incendiary fires set in one year and that effective prevention or the departure of the probable incendiary has removed the concentration of risk for future years. Another area showing unusually great fire occurrence on a map covering several years may prove to be one in which land clearing and burning was in progress during one fall when the weather became dry unexpectedly but since that time little or no new clearing may have occurred and none may be expected in the near future. In this case the area should not be considered a high risk area for the near future. Another area may show a concentration of fires that prove to be campfires occurring at a certain bridge, while later construction of fireplaces and other improvements of the spot have eliminated fires and removed it from the high risk classification.

A map of previous fire occurrence may lead to another error in planning if the map is used in the place of good judgment. Certain localities in which elements of high risk will be present in the future may not show any fire occurrence in the past simply because the risk has developed recently. Or in another case the risk may have been present for several years but through good fortune alone no fires were started. Thus a map of previous occurrence should be used only as an aid to good judgment in outlining high risk areas.

When the high risk areas have finally been selected they should be outlined on a map so that they may be compared later with the map locations of bad fuel types, areas not visible to lookouts, and areas requiring an excessive amount of travel time for the nearest fireman to reach them.

Lookout Coverage Analysis

The next step in the analysis of the fire control job and the present facilities is to determine how well the protection unit is covered by lookouts. It is not sufficient to know the number and location of the lookouts. In order to appraise the protection or detection provided by them it is necessary to know which areas are visible to each lookout and which areas are not covered by any lookout. Within the scope of country over which a lookout can see there are usually many "blind" spots or areas lying behind or below intervening hills and ridges. Spots that are blind to one lookout may be visible to another or to several others combined, but on the other hand there are usually many spots that are blind to all of the lookouts. It is impossible to determine and remember the boundaries of numerous blind spots from casual or hit-and-miss observations. It is therefore obvious that the visible areas and their counterparts, the blind areas, should be drawn on maps. Oftentimes an area of bad fuel type and high risk is not visible to the lookouts, and a fire starting there in dangerous weather might spread beyond control before the smoke rises above the hills. Maps of fuel types, high risk areas, and blind areas can readily be compared so that no dangerous combinations of these factors will be overlooked.

The construction of maps showing the patches of country that can be seen from a lookout point, termed "seen area" maps, will be described briefly. Seen area maps have been made for many millions of acres of forest land in the United States, and three different methods are frequently used. The most obvious method is sketching from the lookout point. The mapper simply outlines on a base map the areas or patches of country that he can see. This requires considerable knowledge of the surrounding country so that visible landmarks such as mountains, valleys, slopes, farms, roads, etc. can be correctly located on the base map as markers for drawing the boundaries of the patches of seen area. The difficulty of identifying each spot of seen area and sketching its boundary increases with the distance of the seen areas from the lookout. Sketching is more difficult in rolling country where the ridges are broad and the drainage courses are not easily distinguished than it is in mountainous country where the ridges are narrow and the stream courses are distinct.

Another method similar to sketching is that of using panoramic photographs of the entire landscape surrounding the lookout and sketching on a base map the patches of country visible in the photographs. A camera designed especially for this purpose revolves slowly as the picture is taken so that one-third of a circle is included in each picture and the three pictures needed for an entire circle fit together perfectly. An azimuth scale and a vertical angle scale appear on the picture so that the precise direction and vertical angle from the lookout to any object in the picture can be read directly. Mapping of seen areas can then be done in the office at any later time. The pictures have additional uses for the fire dispatcher in locating reported fires or in visualizing the location of a fire in relation to slope, timber, burns, etc.

The third method of mapping seen areas uses topographic maps. The boundaries of patches of country visible or blind to the lookout point are drawn directly on the topographic map in the office according to the contour lines and elevations of obstructions to direct visibility. This method requires a certain skill and considerable familiarity with topographic maps. If the contour map is accurate the boundaries of seen areas can be drawn very accurately. In rolling to level topography tall timber may cut off the direct view of considerable areas which would be considered directly visible from a study of the topographic map alone. The errors from this will probably be less, however, than the errors from direct sketching of areas in rolling country more than 5 miles from the lookout.

After the seen area for each established lookout has been mapped the maps should be combined in some way to show how well the protection unit is covered by lookouts when they are all on duty. By drawing the seen area patches for each overlapping lookout in a different color a combined map can be made which at the same time will show the lookouts that see each patch of seen area. In figure 3 a combined seen area map is shown for the same sample area as in figure 2. Two different lookouts see into this area and the patches seen by each are designated by crosshatching. Where the two lookouts see the same area the crosshatching overlaps and forms small squares. From this map the blind areas can be studied and compared with the fuel map and locations of high risk to determine if lookout

coverage in the six sections is adequate and whether additional detection facilities are needed.

The use of seen area maps will be facilitated if the map for each lookout is traced onto transparent stiff material such as celluloid or plasticel. In this form the maps for several lookouts can be placed in their respective positions on a base map of the entire unit and the patches visible to any one or several lookouts can be seen where the transparent maps overlap. They are thus useful and handy for day-to-day dispatching work whenever it is desirable to know which lookouts should be able to see a given point or to know whether a given point is blind.

Road and Trail Coverage Analysis

Transportation routes are the next part of the present protection facilities that should be analyzed. These routes furnish the means for speedy attack of fires after they are reported and govern the area that can be reached with tankers. If complete up-to-date road maps are available the job of analyzing the transportation routes will be small, but if the available maps are poor they should be corrected and brought up to date. In addition to the public roads that are used frequently all secondary roads that are passable in dry weather should be added. These secondary roads are important in sizing up the speed with which a fire can be attacked in any part of the protection unit. A few miles of secondary road may save several hours of foot travel, and the protection job cannot be gaged correctly without allowance for the use of such roads. Additional firemen, patrolmen, tankers, etc. cannot be planned most effectively unless the locations of all passable roads are known in relation to the locations of bad fuel types, high risk areas, blind areas, etc. The local fireman with many years of service may know how to find these roads when needed, but his knowledge of them should be recorded in available map form so that it can be used by the person planning new facilities or by a fireman who has had less opportunity to travel all of the roads.

The roads shown on the map provided for firemen in Clackamas and Marion Counties are illustrated in figure 4 for the sample area of six sections. The additional roads found by traveling over the area are shown in figure 5. The solid double lines indicate surfaced roads. The broken double lines indicate dirt roads that are passable. The dotted lines indicate traces or roads that might be passable for an automobile, but most of them would require work to make them passable and the driving time would be about the same as walking time. This map shows that a great area is open to automobile travel by a fireman or tanker that might not have been included in plans based on the official map illustrated in figure 4.

Additional passable secondary roads such as those shown in figure 5 can be added to available road maps in various ways. In some localities new editions of topographic maps with roads located according to recent aerial surveys are available. These maps are very accurate and complete. The county engineer often maintains a current map record of minor public roads. In other localities it will be necessary for the fire protection organization to gather the information on the ground. This may be done by

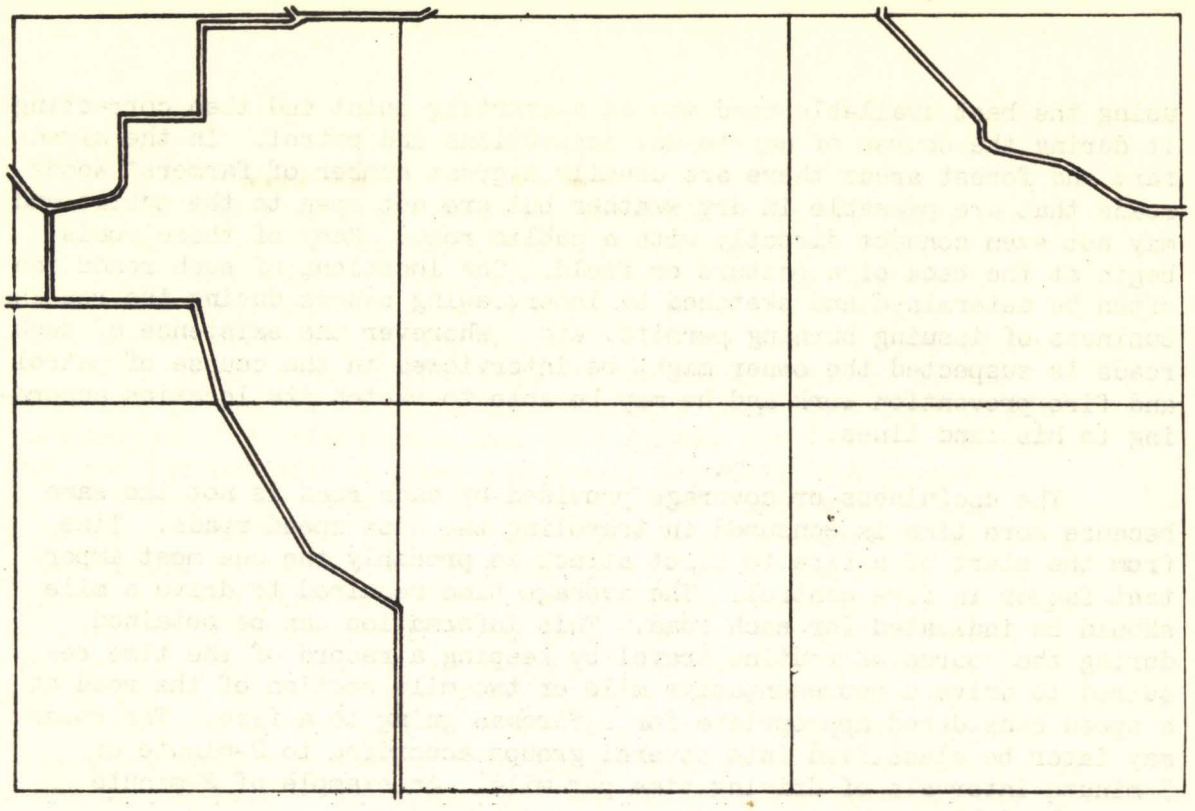


FIGURE 4.--ROADS IN THE SAMPLE AREA OF SIX SECTIONS IN THE CLACKAMAS-MARION PATROL UNIT AS SHOWN ON THE MAP PROVIDED FOR THE FIRE CONTROL ORGANIZATION.

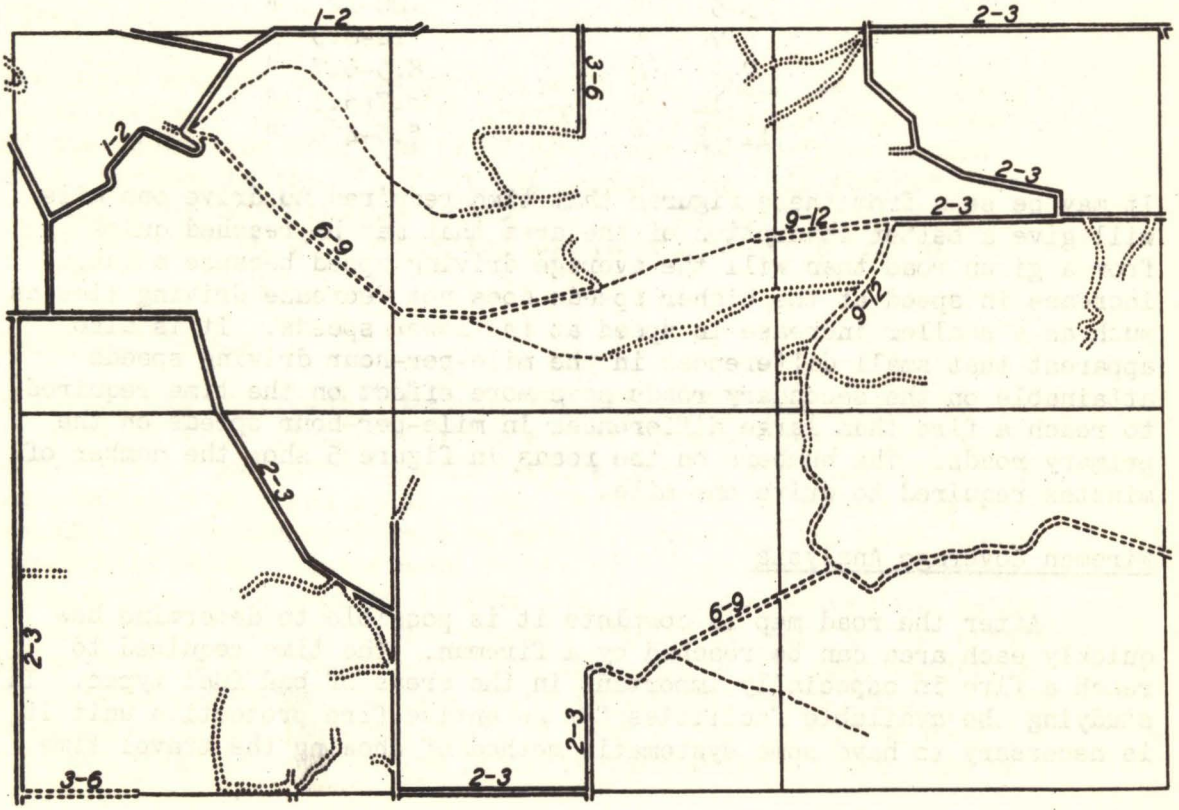


FIGURE 5.--MAP OF ALL ROADS FOUND IN THE SAMPLE AREA OF SIX SECTIONS IN THE CLACKAMAS-MARION PATROL UNIT.

using the best available road map as a starting point and then correcting it during the course of day-to-day inspections and patrol. In the mixed farm and forest areas there are usually a great number of farmers' woods roads that are passable in dry weather but are not open to the public and may not even connect directly with a public road. Many of these roads begin at the back of a pasture or field. The locations of such roads can often be determined and sketched by interviewing owners during the routine business of issuing burning permits, etc. Wherever the existence of such roads is suspected the owner might be interviewed in the course of patrol and fire prevention work and he may be able to sketch its location according to his land lines.

The usefulness or coverage provided by each road is not the same because more time is consumed in traveling the slow speed roads. Time from the start of a fire to first attack is probably the one most important factor in fire control. The average time required to drive a mile should be indicated for each road. This information can be obtained during the course of routine travel by keeping a record of the time required to drive a representative mile or two-mile section of the road at a speed considered appropriate for a fireman going to a fire. The roads may later be classified into several groups according to 2-minute or 3-minute intervals of driving time per mile. An example of 2-minute intervals follows:

Time required to drive one mile	Corresponding driving speeds
1-3 minutes	60-20 m.p.h.
3-5 "	20-12 "
5-7 "	12-8.5 "
7-9 "	8.5-6.7 "
9-11 "	6.7-5.5 "
11-13 "	5.5-4.6 "

It may be seen from these figures that time required to drive one mile will give a better conception of the area that may be reached quickly from a given road than will the average driving speed because a large increase in speed at the higher speeds does not decrease driving time as much as a smaller increase in speed at the lower speeds. It is also apparent that small differences in the mile-per-hour driving speeds attainable on the secondary roads have more effect on the time required to reach a fire than large differences in mile-per-hour speeds on the primary roads. The numbers on the roads in figure 5 show the number of minutes required to drive one mile.

Fireman Coverage Analysis

After the road map is complete it is possible to determine how quickly each area can be reached by a fireman. The time required to reach a fire is especially important in the areas of bad fuel types. In studying the available facilities for an entire fire protection unit it is necessary to have some systematic method of showing the travel time

required to reach each area in which a fire will spread rapidly. One method of showing this information is to sketch on the road map the most remote limits that can be reached by each fireman in several different amounts of travel time such as 1/2 hour, 1 hour, 2 hours. These limits can be determined from the mileage and time required to reach each road intersection by the quickest route from a fireman's station. Then the remaining time in a 1/2-hour, 1-hour, or 2-hour period will be the time available for cross-country foot travel from the intersection. The farthest point from the road which can be reached in the remaining time can then be marked by assuming a reasonable speed of cross-country foot travel. Lines can be drawn more or less parallel to the roads but connecting the marked points or limits of foot travel from each intersection. An example of such a map is shown in figure 6 where the areas beyond the limits of 1/2-hour travel from the nearest fireman station are crosshatched. A table of distances that can be traveled in different lengths of time by different road and foot travel speeds will make the map construction simple. A pencil compass is convenient for marking the limits of foot travel on both sides of a road and in the corners formed by intersections or bends. It can be used also to measure road distances on the map.

Tanker Coverage Analysis

The locations and extent of areas that can be reached by tankers and a given amount of hose are important in analyzing the facilities available for the job of fire protection in any district where the fuel types and water supply make tankers an effective aid to quicker suppression. If tankers are to be used maps of some form should be available to show where the tankers can be used in relation to the locations of different fuel types and high risk areas. This calls for the map of all passable roads as shown in figure 5. Additional field notes should be made on this map to indicate all stream crossings at which the summer flow of water is sufficient for filling a tanker. In the sample area of 6 sections there are numerous fields bordering the roads through which a tanker could be driven to the back fence lines and thus reach a great deal more area with a given length of hose. In figure 7 the areas beyond 800 feet horizontal distance from each road or field are shown by crosshatching. The unshaded area can then be reached by 1,000 feet of hose with some allowance for greater hose distance around obstructions and up- or downhill.

PLANNING IMPROVEMENT OF PRESENT FACILITIES AND METHODS

After the present conditions and facilities affecting the protection job have been systematically studied certain improvements that are needed in facilities and methods will be obvious. (Others may be less apparent and require further study.) Plans should then be made for developing these needed improvements. In the following section of the report the systematic steps for discovering and planning the improvements needed will be described briefly for the sample area of 6 sections in order to demonstrate how it might be done for an entire protection unit. Many details are omitted to avoid confusion and focus attention on the principles.

Prevention Planning

The list of high risk areas or areas in which fires are liable to start should receive special consideration. If certain localities are liable to have concentrations of man-caused fires it may be prudent to spend a lot of time figuring out ways to prevent those fires rather than spend a small amount of time figuring out ways to stop them quickly after they start. Even though none of them have gotten beyond control in the past there is always the threat of having one start under the right combination of weather and fuel conditions that will spread the fire beyond control. The methods used for preventing these fires will depend on the probable causes and the thoughts and habits of the people who start them. Each high risk area should be considered and studied separately to determine what prevention steps should be taken. An intimate knowledge of the ideas and activities of the people who start the fires is absolutely necessary for successful prevention. If local people in a certain locality are causing many fires it may be advisable to work out a plan of gathering information about their ideas of fire. This may take several years but the results may be worth the time. If analysis of the information shows the fires are due to carelessness the prevention steps would take the form of frequent reminders. If the fires are due to lack of knowledge of fire behavior and safe methods of handling such things as burning tobacco, land clearing fires, debris fires, slash fires, etc., the prevention steps would be education and repeated instruction in the safe methods. If the fires are set with the intention of having them spread beyond control two principal steps are open. One is to change the desire of the incendiary by making him think it is to his economic advantage if fires do not occur. The other is to make him afraid to set a fire.

Where fires are not concentrated in high risk areas the prevention steps are less obvious. If the people causing the fires are from communities within the protection unit a plan of education and reminder should be devised and applied to them in their own communities. If the fires are caused by people outside of the protection unit it may be necessary to depend on reaching them by both education and reminders after they enter the unit.

Hazard Reduction Planning

The hazard map in figure 2 showing the bad fuel types should be examined. Areas of types liable to cause a fast rate of spread that are readily accessible to the public should receive special consideration. If such an area contains unburned slash it may be possible to reduce the hazard by burning. If the hazard cannot be reduced, possibly the area should be closed to public entry. Notes made by the fuel type mapper concerning the extreme hazard area in section 34 show that abandoned shacks and heaps of slabwood and sawdust around an old sawmill site cause most of the hazard. Plans might be made to burn this debris and thus remove the most dangerous part of the hazard. Wherever bad fuel types containing snags occur in high risk areas as shown by the previous study of risk a plan should be made to fall some of the snags as soon as the labor is available. If the area of

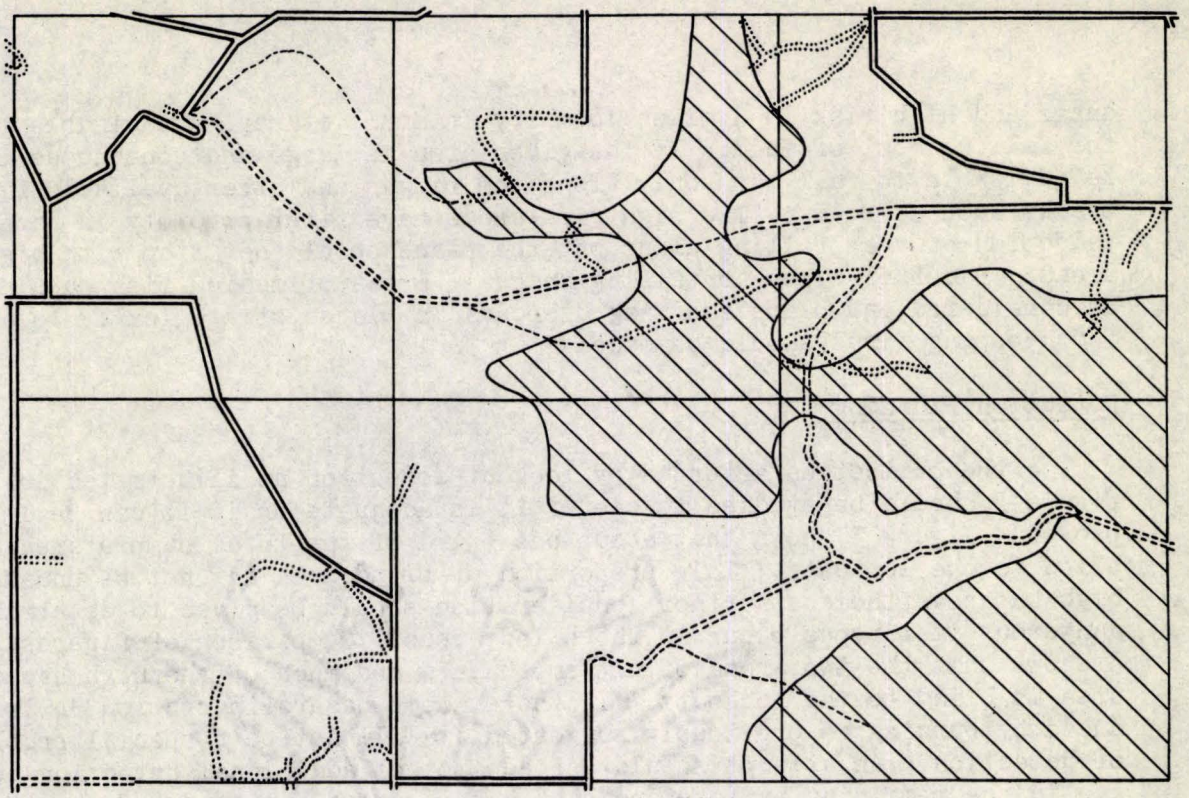


FIGURE 6.--PARTS OF THE SAMPLE AREA OF SIX SECTIONS IN THE CLACKAMAS-MARION PATROL UNIT THAT REQUIRE MORE THAN 30 MINUTES TRAVEL TIME FROM THE NEAREST FIREMAN STATION ARE INDICATED BY THE CROSS HATCHING. TRAVEL TIME INCLUDES 3 MINUTES FOR GETAWAY AND IS BASED ON THE QUICKEST ROUTE USING THE TIMES REQUIRED TO DRIVE ONE MILE SHOWN IN FIG. 5. A FOOT TRAVEL TIME OF 30 MINUTES PER MILE WAS USED BEYOND THE ROADS. TRACES WERE NOT USED IN PLANNING AUTOMOBILE TRAVEL.

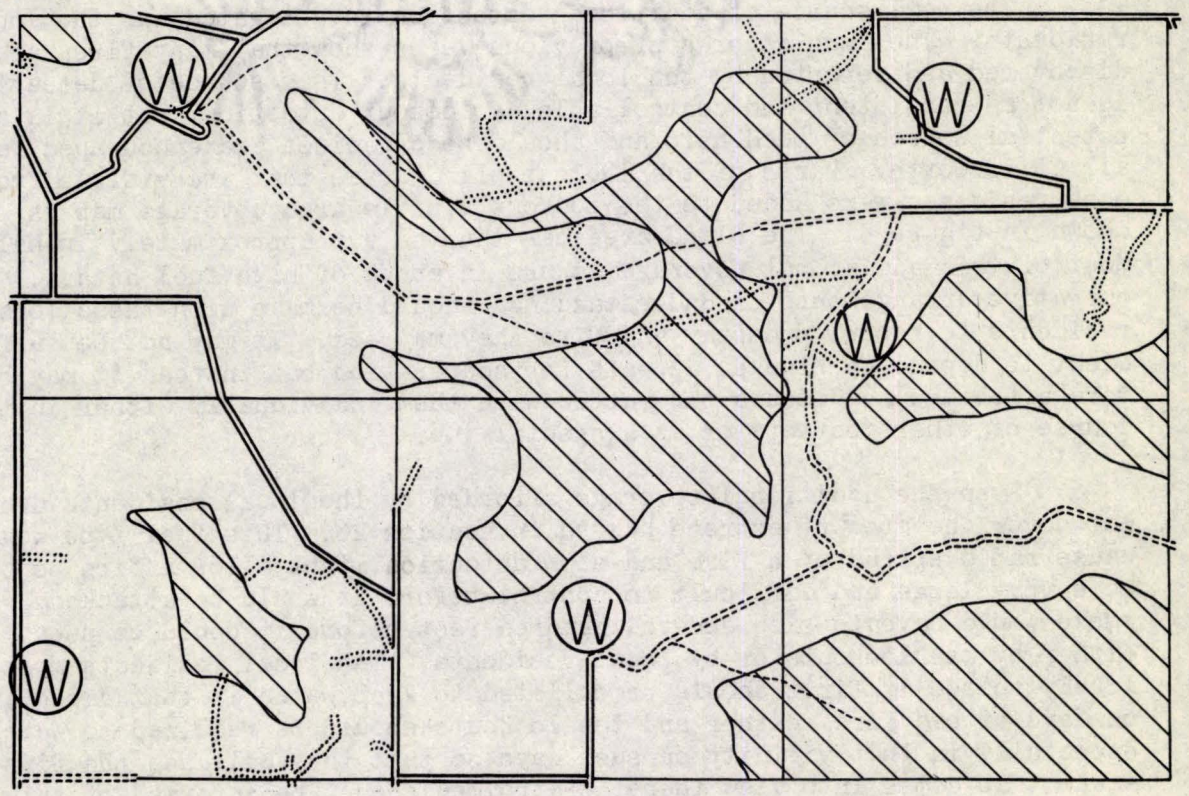


FIGURE 7.--PARTS OF THE SAMPLE AREA OF SIX SECTIONS IN THE CLACKAMAS-MARION PATROL UNIT BEYOND THE LIMITS OF TANKER COVERAGE ARE INDICATED BY CROSS HATCHING. ALL PASSABLE ROADS AND AGRICULTURAL LAND (SEE FIG. 2) WERE CONSIDERED OPEN TO TANKER TRAVEL AND A HOSE RADIUS OF 800 FEET WAS USED. THE SYMBOL Ⓦ INDICATES ROADSIDE STREAMS WHERE THERE IS SUFFICIENT WATER FOR FILLING A TANKER.

snags and high risk in a given locality is small it may be advisable to plan for falling most of them. If the given area is large and continuous it may be advisable to fall them only along the ridges and other available fire-breaks such as roads. The high risk areas have first priority in hazard reduction or snag falling plans but the plans should not stop with high risk areas. Bad fuel types containing snags in areas of medium risk should next be considered and plans for snag disposal in places strategically located for stopping fires should be made.

Detection Planning

The protection afforded by lookout detection as illustrated in figure 3 should be studied to see if it is adequate or if it can be improved. Figure 3 shows that about one-third of the total sample area is blind to the lookouts. This proportion of blind area may not be unusually high but nevertheless further consideration should be given to determine if dangerous fuel types occur in the blind areas. Comparison of figures 2 and 3 shows that the two areas of extreme hazard and much of the high hazard area is blind to the lookouts. If the extreme hazard in section 34 is reduced by burning as previously suggested it will not be a special problem of detection. An attempt should be made to get additional detection coverage in the remaining extreme and high hazard areas. A study of the topography showed there is no opportunity for better coverage of the sample area by shifting the present lookouts and an additional lookout placed in the vicinity of the sample area could not see enough area to pay for the expense.

The next source of additional detection investigated was the local residents. The fire records of previous years show that many fires are discovered and reported by the local residents. This source of detection is not as consistent and controllable as lookout detection, but it is a potential source of much help and should be organized and encouraged for all it is worth. Parts of the lookout blind areas that are visible from each residence were added to the lookout visible area coverage map as shown in figure 8. The blind area can thus be cut approximately in half. Most of this additional coverage occurs in areas of high fuel hazard. Cooperative arrangements or understandings should be made with these local residents to report promptly any fire they may see. It may not be sufficient to depend on blanket appeals for cooperation but instead it may be more effective to discuss the matter with them individually either in the course of other contacts or as a special job.

Even the additional coverage afforded by the local residents does not cover the area of extreme hazard in section 26. This fuel type would cause rapid spread of a fire and slow detection might allow a fire to become very large and difficult to control before it would be attacked. The smoke would have to rise several hundred feet before it could be seen either by the lookouts or by local residents. The local residents most likely to see it first should be enlisted to keep watch in that direction on days of bad fire weather and the lookouts should be required to watch especially in that vicinity on such days so that they will see the first smoke that comes into view there. Patrolmen should be informed of this blind area of extreme hazard and should pay special attention to it.

Fireman Coverage

The map of all passable roads, the time required to travel them, and the half-hour fireman travel coverage as shown in figures 5 and 6 indicate that the present available routes of travel are adequate with the possible exception of the vicinity of the extreme hazard fuel types. A secondary road along the trace on an old railroad grade through the extreme hazard area in section 27 (fig. 2) should be considered. This would give only a few minutes' saving in fireman travel coverage but would make the area accessible to a tanker. If the extreme hazard in section 34 is reduced by burning as suggested it needs no further consideration. If it were not reduced a branch from the nearby secondary road might be built along the trail location, which is an old logging road. Here again the saving in fireman travel time would be only a few minutes but the area would be open to tanker attack.

The fireman travel time coverage shown in figure 6 could be improved by the addition of a fireman station within about 10 to 15 minutes' driving time of the east edge of the sample area. The present station having quickest access to the area is southwest of it. A cooperative agreement should be made with several local residents to act as first attack firemen in case a fire is reported in the extreme hazard area of section 26.

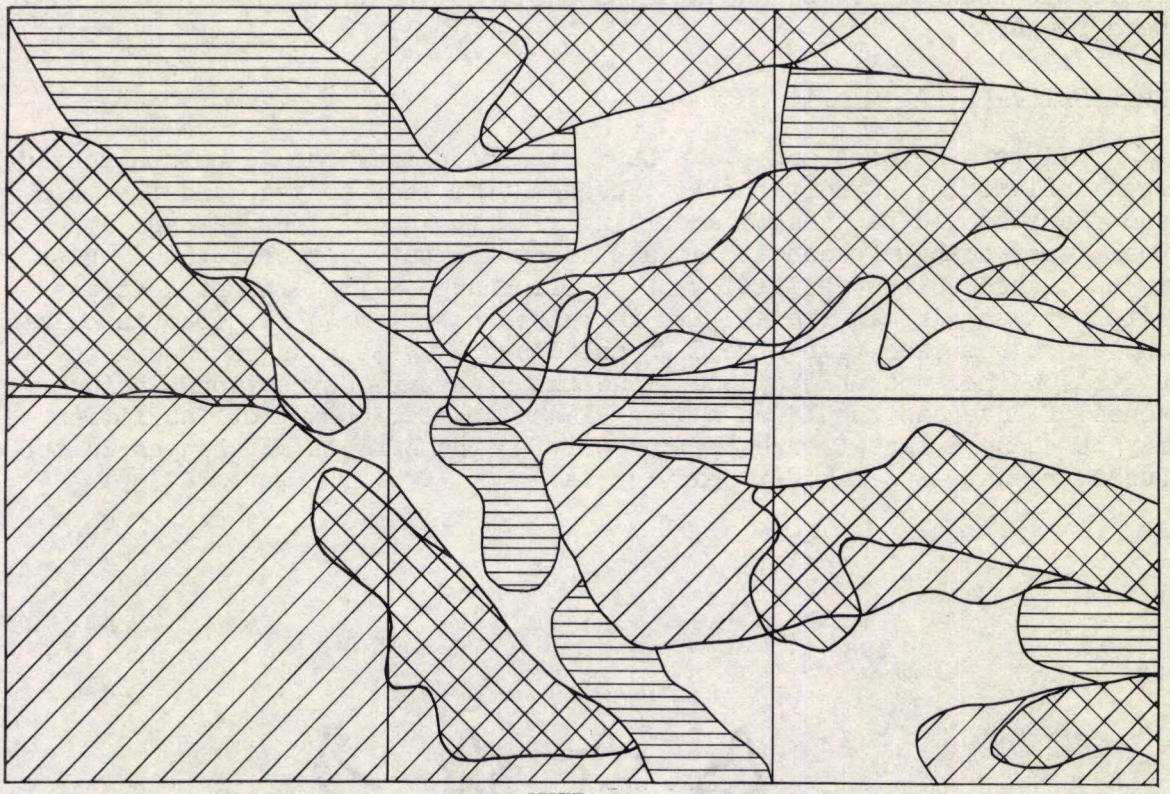

LEGEND
AREA VISIBLE TO ONE LOOKOUT
AREA VISIBLE TO A SECOND LOOKOUT
AREA VISIBLE TO BOTH LOOKOUTS
ADDITIONAL AREA VISIBLE TO LOCAL RESIDENTS

FIGURE 8.--PARTS OF THE SAMPLE AREA OF SIX SECTIONS IN THE CLACKAMAS-MARION PATROL UNIT NOT DIRECTLY VISIBLE TO ESTABLISHED LOOKOUTS BUT VISIBLE FROM THE HOMES AND FIELDS OF LOCAL RESIDENTS

Tanker Coverage Planning

The relatively large proportion of the sample area that could be reached by a tanker with 1,000 feet of hose and the abundant water as shown in figure 7 indicates that these items are favorable for the use of tankers in the sample area. Analysis of the fire reports showed that 95 percent of the man-caused fires are within 1/4 mile of a road. Thus accessibility of most fires to attack by tankers is probable. In the fast spreading fuel types water will often enable one man or a small crew to hold a hot fire until the additional help arrives that is necessary to put the fire under control. If a large part of the Clackamas-Marion fire patrol unit is like the sample area the sufficiency of present tanker equipment and the need for additional tankers should be considered.

Adoption of Plans by Conference

The foregoing discussion illustrates the first steps necessary in planning the needs of a fire control unit. After the preliminary plans for alteration and addition of facilities it is usually necessary to make the final decisions and plans through the joint appraisal and consideration of several persons. At such a conference the maps can be used as a basis for decisions where intimate personal knowledge of a given hazard area, visible area, zone of fireman travel time, etc. may be lacking. Proposals and counter proposals for additions and changes of fire control facilities can be sifted and studied until the best acceptable plan has been reached.

Keeping Plans Up To Date

After the maps and plans have been made they should not be considered inflexible. Conditions will change from year to year and the maps and plans should be changed accordingly as the conditions warrant it. Fuel types change frequently as new areas are cut over or burned. Risk areas change as the activities of people change. The area of coverage with a given fireman travel time increases each time a new road is built and decreases each time a road is abandoned. These changes should be posted on the maps as they occur and the necessary corrections in the zones of coverage should be made. Plans for development of facilities may be changed less frequently and only as the effects of changes in the fuels, roads, etc. make it practicable.

Part III
RECOMMENDATIONS FOR ATTAINING ADEQUATE FIRE CONTROL

Objectives

The first step in attaining adequate fire control is the determination of objectives. These objectives should be translated into definite goals that can be used in daily administration to obtain adequate fire control. Ideal fire control would be attained by the elimination of all fire losses but that is not a practicable objective because economic considerations make it necessary to accept as adequate something less than the ideal. Determination of adequate forest fire control is essentially an economic problem. The term "adequate" itself implies a compromise; adequate fire control is not absolute or ideal or perfect fire control, but it is an attainable level of fire control somewhere between perfect control and no control which will maintain the forest values on forest lands with due regard to economic considerations such as the balance between costs and losses.

Before it is practicable to go very far in setting up the objectives of fire control it is necessary to answer the question, To what shall adequate fire control be applied? This is especially important in an area such as the Clackamas-Marion patrol unit where forest lands are intermingled with agricultural lands and where there are also important values in buildings and other combustible properties on or near forest lands. Earlier in this report the statement was made that in a highly developed community all properties needing protection should be protected from fire and that this protection is a proper responsibility of government. But this does not define the scope of forest fire control. There is room and need for three kinds of fire control to attain universal fire protection in the Clackamas-Marion patrol unit and similar areas. These are: Municipal fire departments such as are already provided in all cities and towns; rural fire control; and forest fire control. Forest fire control agencies will have to decide the boundaries between rural fire control and forest fire control. Solid blocks of forest land should be assigned to a forest fire control agency and solid blocks of farms should be the responsibility of a rural fire control agency prepared to give year-round service. In borderline cases, as for example in areas of mixed farm and forest, responsibility for fire control should be delegated on the basis of efficient administrative boundaries. Universal fire control should be the objective and the forest fire control agency should carry its full share in attaining this goal.

There does not appear to be any basic reason why rural fire control and forest fire control cannot both be provided in some cases by one agency. In fact, this would be more desirable than breaking down areas into fire control units too small for efficient management. There is greater danger of making the units too small than of making them too large.

It was stated in the analysis section of this report that a fire loss from all fires of less than 1/4 of 1 percent per year of the area protected should be acceptable. To be specific, this might mean that a loss rate of about 1/10 of 1 percent per year should be acceptable.

If this loss rate could be attained on the cutovers (those that have been burned over by slash fires), burns and high hazard types in general, which total about 180,000 acres, the same effort and facilities would probably produce even lower losses on the low hazard types such as large second-growth and old-growth timber and provide an acceptable level of protection for the entire unit. Applying the 1/10 of 1 percent loss rate to the 180,000 acres of the high hazard type indicates that not over 180 acres of this type should be burned per year or not over 1,800 acres in 10 years.

The factors influencing the area burned in the high hazard fuel type should be studied to determine how the objective of 180 acres maximum allowable burn per year in the type can be attained. Previous studies[7] of rates of spread in different fuel types show that fires in the high hazard types on a moderate slope under weather conditions like those on the majority of bad fire weather days will increase in perimeter at a rate of 40 chains per hour. Other studies[7] show that each chain of perimeter in fuels like the high hazard type of the Clackamas-Marion patrol unit will require two man-hours of control work. If it is assumed that the fire will be discovered by a lookout while it is very small, less than 1 chain in perimeter for example, and that with quick dispatching and getaway a crew of 25 men will reach the fire within 1 hour after it is discovered, then the fire will have a perimeter of about 40 chains when the crew arrives. Since in this fuel type the crew will control on the average only $12\frac{1}{2}$ chains of perimeter per hour (25 men divided by 2 man-hours per chain) they cannot stop the spread of the fire increasing in perimeter at the rate of 40 chains per hour except under favorable strategic conditions. If, for example, that spread is occurring on a head that can be gradually pinched off by the slower control rate of $12\frac{1}{2}$ chains per hour and if the flanks do not spread greatly in the meantime the crew may control the fire before it escapes entirely. In this case the crew is actually decreasing the average rate of spread by eliminating the sectors spreading at 40 chains per hour and then controlling the slower spreading sectors. If control of the fast spreading sectors is achieved within a few hours through conditions favorable for clever strategy the final perimeter of the fire in this example might be held to 120 chains. The area corresponding under most conditions to 120 chains of perimeter will not be over 50 acres. If, on the other hand, a 25-man crew controlling $12\frac{1}{2}$ chains of perimeter per hour cannot through strategy pinch off a head spreading at a rate of 40 chains per hour the fire will exceed 225 chains of perimeter within a few hours. This perimeter under most conditions corresponds to about 180 acres or the objective of total allowable burned area per year.

These considerations show that fires burning in the high hazard fuel types on days of average bad fire weather can be held within the allowable burned area objective only if they are attacked quickly with considerable crew strength. Since the probable rate of spread is equal to the average control rate of 80 men, attainment of the burned area objective will depend largely on prevention of fires in this fuel type,

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7/ Unpublished data of Pacific Northwest Forest and Range Experiment Station.

quick detection, efficient distribution of fire crews, quick attack, skillful application of fire fighting effort by the entire crew, and use of mechanical aids that will increase the rate of controlling each chain of perimeter.

The above discussion indicates that some of the fires in the high hazard fuel types may not be controlled by the first crew or crews who go to them. Also, many fires in the very fastest spreading or "extreme" fuels, such as fresh unburned slash, will keep on spreading in spite of the best efforts of the initial attacking crews. Such fires will tend to burn out to and beyond the boundaries of the fast spreading fuels and they may exceed 180 acres in a few hours if there is an extensive acreage of such fuels. To attain adequate fire control and a low burned area objective every fire must be controlled promptly and this means that all fires not controlled by the initial attack should be controlled in the first work period. To accomplish this it is necessary to put enough men and equipment on each and every fire to stop its spread before burning conditions again become favorable. For a fire discovered in the afternoon this means that it must be controlled before burning conditions become favorable again the next morning.

The sections which follow recommend what should be done about finances, administration, prevention, detection, communication, large fires, equipment, weather and fire danger, records, personnel and training in order to attain the objective of adequate fire control.

Finances

The emphasis herein placed upon the need for universality in fire control leads naturally to the position that the financial support of fire control should also be universal. Fire control--forest fire control and all fire control--is a proper function of government and as such should be supported by taxes collected from all properties. Fire control is perhaps the principal direct service that government can render to private forest lands and therefore it would be entirely reasonable to expend a major part of the taxes collected from forest lands for fire control thereby eliminating the need for special assessments. The objective of universal fire control carries the very strong corollary objective that all properties should share in financing fire control.

Administration of Forest Fire Control

To attain adequate forest fire control definite objectives, plans, and policies must be provided the personnel to guide them in the conduct of all activities. Definite policies of fire control action should be established and included in the training program so that even the newest employee will know what action to take on a fire and on other phases of his job. Lines of authority should be clearly established. Every employee should understand his place in the organization. Every employee should know for whom he is working and to whom he can give orders. These are matters that are extremely important to a forest fire control organization

because fires must be fought without delays and lost motion under all manner of unpredictable circumstances. Handbooks, inspections and training programs are all excellent devices for acquainting employees with objectives, plans and policies and for developing a strong organization.

Private landowners and operators have an important place in the administration and organization of fire control in Oregon. Their duties and responsibilities are established in existing laws. Administration and enforcement of these laws is a major function of the State Forester. This is an important phase of fire control administration but it is not the only one. The forest fire control agency should be the leader in its field and actively advise and help landowners and operators. Cooperative arrangements can be made which will be of mutual benefit. The fire control equipment and personnel on private operations can be of very real help to the local fire control organization and this can work the other way around too. Adequate fire control on individual woods operations, logging, sawmilling, woodcutting, land clearing and debris disposal is necessary as a foundation before the fire control agency can attain adequate fire control on all forest lands.

Forest fire control is not static. One of the functions of management is planning. There should be a constant effort being made to improve the efficiency and effectiveness of all fire control activities. Plans should be made for the development of personnel, equipment, improvements and all the things needed to obtain better fire control at less cost. The clever manager will have always on hand a "shelf of projects" or plans for tankers, towers, roads, etc. all worked out in advance which he can use whenever the opportune moment arrives.

Prevention

Several specific recommendations can be made about prevention activities in the Clackamas-Marion patrol unit which should contribute to the attainment of adequate fire control. A spirit of mutual interest and cooperation should be maintained with local residents, woods operators, and the public in general. This is a fundamental requirement for success in any fire prevention activity. There should be positive control of all fire starting agencies. This means effective closures whereby the public will not be allowed to enter the most dangerous forest areas. Fire precautions on logging and milling operations should be such as will produce positive results. Fire control provisions of operating permits should be effective and they should be strictly enforced. Control over the use of fire should be more positive than it has been in the past. It should be inexcusable for any permit fire to become a reportable fire. Fire danger and fire weather measurements should be used to guide the administration of all kinds of controlled burning. Hazard reduction should receive adequate attention. Logging slash and other dangerous fuels should be promptly disposed of. Controlled burning is necessary and desirable, especially where, as in slash and debris burning, it will reduce the hazard, but it should be so conducted that it does not cause any reportable fires. This is a field of fire prevention that is subject to complete control by skillful, strong, positive action. The fire control agency should be held

responsible for all controlled burning on all lands of all ownerships.

Detection

As a first step in strengthening detection it is strongly recommended that seen area maps be prepared from all developed lookout points and that these maps be studied in combination to determine where the major blind spots are and how they can be eliminated. When the seen area maps are made they can be used to show where additional lookouts should be located, but it is doubtful if any reasonable number of lookouts can ever give complete coverage. To attain this objective it will be necessary to enlist the help of people living in blind areas or to provide special patrols or watchmen for especially dangerous fuels in blind areas. Most certainly every bit of unburned slash and other high hazard fuels in blind areas should receive special attention to see that they are covered by some detection agency.

In developing detection facilities it should be remembered that the local people and the traveling public already report many fires and everything possible should be done to encourage and to facilitate this cooperation. Since quick attack is imperative in most cases, all fires should be reported as quickly as possible after the first person discovers them. The public should be made aware of this. In addition the public should be encouraged and actively urged to report every fire seen unless it is certain that the fire is already being attacked. A passerby seeing a large smoke should not feel that someone else has probably reported it already and that his own report will be considered more of a bother than a help by the protection agency. In contrast he should be trained through public education to feel that it is his duty to report a smoke even though the chances are great that someone else has already reported it. Duplicate reports can always be discarded but a fire that is discovered and not reported may gain such headway before someone finally reports it that rapid and economical control of the fire will be impossible.

The public should be adequately instructed in the procedure or methods for reporting forest fires. The motorist who sees a smoke should know at once from public instructions that he should make a note of the exact location with reference to landmarks and road distances and then should stop at the first house showing a telephone lead-in where he should call the central operator and either give her the report or talk directly to the fire warden. If in a sparsely settled area where there is no telephone nearby he should feel duty-bound to take any other necessary steps to report the fire or to enlist help in doing so.

People living within the protection unit can be instructed through various channels as to the importance and procedure of reporting fires. Local clubs, granges, schools, newspapers and posters should be used in the campaign. Other Oregon residents outside the protection unit should be instructed by State-wide forest protection organizations such as the State Forester's Office, the Oregon Forest Fire Association, Keep Oregon Green, and the U. S. Forest Service. Newspaper advertisements, radio announcements, service club campaigns, youth organizations, folders,

stickers, posters, etc. are some of the State-wide channels of instruction. Instructions in reporting fires will serve the further purpose of preventing careless man-caused fires because the importance and danger of forest fires will thus be impressed upon the public.

Methods of getting the report to the warden when there is no telephone nearby, such as hailing a passing motorist headed toward a more settled area, should be suggested in the educational campaign so that people will think of various possibilities in a time of emergency. Suggestions for alternate ways of getting a report to the warden when a phone is not handy will serve to impress upon the public the need for reporting fires.

The adequacy of telephone reporting points in sparsely settled areas of dangerous fuel types should be studied and if a given situation warrants it consideration should be given to enlisting a local resident with a car to serve as a messenger for reporting fires. Other nearby residents can then inform the messenger of a fire, while otherwise they might delay or fail to report it owing to inconvenience.

Communication

In order to attain adequate fire control standards the warden should have fast, dependable communication with all members of his force, with cooperators, and with woods operators of all kinds. It should be possible to have 24-hour telephone service when needed. Since considerable dependence must be placed upon rural telephone lines the fire control agency should do all that it can to improve these lines. Special plans should be made for obtaining adequate telephone service during peak fire loads. The radio should be used to supplement and strengthen telephone communication. The radio is especially valuable for use in connection with fire chasing and fire suppression.

Transportation

Suggestions for analyzing and planning the road system were included in the discussion of the sample area of six sections. All roads and traces that are important for fire control should be kept open for use. There are many miles of logger and woodcutter roads that could be kept open with a little attention to drainage and bridges. Roads, traces and trails should be accurately recorded on a map and the map should be used in dispatching, in fire chasing, and in preparing fire reports. Gathering and mapping accurate and detailed road information should have high priority. It is believed that as maps become more accurate and complete they will be used more. Therefore it is not fair to judge the probable use of such maps on the basis of use made of the present inaccurate and incomplete maps.

Equipment

Since most of this sample area is well supplied with roads, especially those parts of it that have the high hazard fuels and most of the fires, it appears that tank trucks can be used to good advantage. It has been shown that most of the fires have occurred close to roads. Practically

all of the logging and woodcutting that produces most of the high hazard fuels can be reached by a tank truck. There is also the possibility that the prompt use of water will reduce the number of men required for fire fighting, which is an important consideration when men are hard to get. It would seem desirable to have enough tank trucks properly distributed so they can reach in 30 minutes of driving time most of the territory where they can be effective.

Tractors can be used for constructing fire control line quite generally over the Clackamas-Marion patrol unit, especially at the lower elevations where the topography is level or rolling. It would seem desirable to be able to put a properly equipped tractor to work on any fire in the high hazard fuel types within one hour after it is reported. Since there is a high speed highway running north and south along the west side of the unit one tractor outfit on a truck stationed near the center of the unit on this highway should be able to reach a large part of the unit within one hour after a fire is reported. Two hours of travel time should get it to almost any point on any road in the unit.

Fire Suppression

Good practices or methods of fire suppression have been developed from the trials and successes of experienced men during more than 35 years of organized forest fire protection in western Oregon. The results of much of this experience and the most reliable methods of suppression have been published as manuals[8/9/10] for the use of fire fighters. Complete knowledge of the material on fire suppression in these manuals should be required of all seasonal employees of the Clackamas-Marion patrol unit. Fires frequently burn beyond control because someone fails to follow the best practice in fire suppression or because he follows a practice that time after time has proved to be undesirable. The use of approved practices should be required on all small fires to prevent them from becoming large, and the work of seasonal employees on small fires should be inspected to determine if these practices are well understood and applied.

In addition to using the best practices of suppression on the fire line there are several other requirements for an efficient suppression organization. If the objective of controlling all fires while small is not attained and a fire becomes so large that crews must be hired in addition to the regular organization a prearranged plan for expansion should be available. If such a plan is prepared in advance when there is sufficient time to consider thoroughly all of the details it may save costly oversight. An expansion plan to handle a large fire should include a list of the sources and the order in which they should be used if 50, 100, 200, or 400 men are needed. Since some of the sources are liable to fail in an emergency, alternate sources should be planned and listed. If these plans are made in advance valuable supervising time may be saved when it is most

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8/ Western Forestry and Conservation Assoc. Western fire fighter's manual. 6th ed. 8 chs. Portland and Seattle. 1931-34.

9/ Oregon Dept. of Forestry. Fire wardens' handbook. 95 pp. Salem. 1939. [Mimeographed]

10/ U.S. Forest Service, Region 6. Fire control handbook. [Processed]

needed and the crews may be placed on the fire line more quickly at a critical time. Especial consideration should be given to means of getting logging crews together on week ends.

Plans for providing tools, food, and camp facilities should accompany the plans for large crews of various sizes. Valuable time on the fire line may be lost if crews arrive and do not have the proper equipment waiting for them.

Planning for large fires should include the training of men required in the key positions. Reliable persons who are likely to be available for large crews should be given preliminary instructions and training in the jobs of supplying and managing a fire camp, keeping payroll time records, and managing tools and equipment. These are jobs requiring considerable ability and experience, and if not done efficiently a great number of man-hours of work on the fire line will be unduly delayed. If these positions in the supply organization are filled with men hired for the duration of the fire, the regular and seasonal employees can devote their specially trained skill and leadership to controlling the fire.

Other persons capable of leadership in fire fighting who are likely to be hired for large fires should be given preliminary training in the approved methods. Reliance should not be placed entirely on a man's previous practical experience. His previous experience may not have included certain situations that might prove critical on a fire. Every leader should have clearly in mind the fundamentals of correct fire line location, rapid construction of line with neither undue elaboration nor risky skimping of work, and approved methods of mopping-up. Foremen of logging and mill crews that are liable to be employed in emergencies should be included in the preliminary training. This training should be completed before the beginning of the fire season and should be repeated for each man annually if possible.

The trained personnel of other patrol units should be used as much as practicable on large fires that strain the resources of one unit. This will provide better trained men for the suppression job and will increase the experience of the seasonal employees in the unit lending them.

Various types of organized suppression squads or crews drilled to work together most efficiently with high speed standards of fire line construction have proved highly successful in recent years. It has been demonstrated that such squads are more often successful on critical sectors of a fast spreading fire than are larger numbers of untrained men. A suppression squad made up of highly capable seasonal employees should be drilled at the beginning of each fire season and should be used as a unit on large fires whenever a highly skilled hard-hitting attack on one sector may prevent a major increase in spread of the fire. At such times the trained seasonal employees are often more valuable as a fire fighting squad than as foremen for less efficient workers.

Weather and Fire Danger

Weather is a very special concern of fire control in the Clackamas-Marion patrol unit just as in other parts of Oregon and Washington. Weather is tremendously important because it largely determines in any one fuel condition whether fires will start and how fast they will spread if they start. On one day a shower of sparks can fall in new slash and nothing will happen; a few days later any one of those sparks may start a conflagration. The skillful fire control executive must know what the weather is doing to the fuels he is protecting. He must know every day what a fire will do in any part of his district. He must know when it is safe to issue burning permits and when it is safe to burn a slashing. Upon his knowledge of these things much of his success depends. The attainment of an acceptable level of fire control at an acceptable cost also depends very largely upon correct appraisals of burning conditions.

There is no substitute for good judgment, keen observation and experience in keeping abreast of burning conditions but there are devices that can be useful aids. Fire weather forecasts are one such aid. Also, burning conditions can be measured by measuring the moisture condition of fuels and the wind velocity. Combinations of these two factors, sometimes called burning index values, can be used to indicate burning conditions as related to danger of fires' starting and rate of spread after they start. Therefore it is possible to use actual measurements of physical factors as the fundamental information to use in exercising good judgment. The soundness of this approach is well recognized. Fire danger measurement has passed the experimental stage and when used along with the fire weather warning service of the Weather Bureau it is now part of the daily routine of good fire control management.

One complete fire danger station with fuel moisture sticks, hygrothermograph (with fan psychrometer for checking), wind gage and rain gage should be in yearlong operation at the warden's headquarters. Yearlong operation is recommended in order to get information about burning conditions during the winter months as well as in the early spring and late summer. Such a station will also take observations for the forest fire warning service of the Weather Bureau. In addition to this station near the center of the patrol area the fuel moisture sticks and wind gages could be used to advantage in at least two additional places, one in the north and one in the south part of the area. Such a system of three stations, supplemented with similar stations on major logging operations, would probably give sufficient coverage.

Daily or more frequent reports of conditions at all fire danger stations on the patrol area and at adjacent national forest stations should be made available at the warden's office and used with the daily forecasts from the fire weather service as a guide in deciding upon certain types of closures, issuing burning permits, burning slash, and other administrative action. They can also be used to determine when to put on and when to take off men and the number required. The fire danger measurements can also be used in fire prevention. Special prevention measures can be taken on days when burning conditions are extremely

dangerous. Once the measurements are available many uses will be found for them as a powerful aid to good judgment.

Records

Analysis, self-criticism, and a constant determination to make improvements and increase efficiency are essential to the development of adequate fire control. The problems of fire control are changing all the time and the fire control organization must be always critical of its own performance and alert to the possibilities of improved practices which will give the best possible protection for every dollar spent. Records of various kinds are, of course, needed in the daily administration of fire control, but the emphasis here is on their value for making analyses leading to improved practices and more economical operation. They are also useful in gaining support for fire control. Complete and accurate fire reports, cost records, burning permits, operating permits, entry permits (or registration records), fire danger records, weather records, visibility records, inspection reports, hazard reduction reports, cutting records, records of roads, trails, telephone lines, buildings and equipment, personnel records, and diaries are types of records needed for essential analyses that will enable a fire control organization to keep ahead of its job. Complete and accurate maps are basic to the keeping of records. But record keeping should not become an end in itself. Records are valuable only to the extent that they are used and analyzed and become vital to the organization. Therefore they should contain only essential information, and skill and experience should be used to avoid waste of time on worthless details.

Fire records are so important that they deserve special mention. Each and every fire should be the subject of a complete and accurate record, and these records should be used to improve fire control practices and increase efficiency. They can be used as a training device and as publicity material to gain public support of fire control. The fire reports of all agencies, Federal, State, and private, should follow one pattern and be consistent so they can be combined. To this end the same definitions of terms of such items as causes, reportable fire, etc. and the same damage appraisal specifications should be used by all fire control agencies. Fire records should be stripped of all nonessentials in order not to waste the time of busy field men. Experience indicates that certain items can and should be used in making studies and analyses for improving fire control. The following list includes some of the more important of these items:

1. Location.

   Point where fire started.
   Map or other record of area burned (larger fires only).

2. Cause of fire. Record known causes; otherwise record as unknown.

   General cause--railroad, smoker, logging, etc.
   Specific cause--brake shoe, cigarette, sparks from donkey, etc.
   Person or class of people responsible.

3. Physical conditions.

Relation of fire to seen area of lookout points.
Visibility conditions at time fire was discovered.
Fire danger--fuel moisture content and wind velocity at time fire was discovered and during its subsequent spread and control.
Kind of fuel and fuel type.
Topography.

4. Behavior of the fire.

What was fire doing when first man arrived--smouldering, creeping, running, spotting, or crowning?
Amount of spread during period of control work.

5. Action and time record.

Time of origin if known.
Time of discovery and name of discoverer.
Time report was received and name of reporter and receiver.
Time of first attack and names of fire fighters.
Time reinforcements arrived and names.
Time the spread of fire was stopped.
Time the fire was out. Name of person responsible for saying fire is out.
Name of individual or agency legally responsible for fire control action.
Total number of man-hours worked.
Distances traveled for initial attack and method of travel.
Type of equipment used (tanker, tractor, pumps, etc.)

6. Damage (larger fires only).

Ownership of land burned.
Map or other record to show area burned by cover types.
Amount of timber, reproduction, etc. killed. Use forest survey types or combinations of them.
Value of damage in dollars.
Other effects of the fire such as erosion, loss of recreational values, etc.

7. Other information. A brief narrative should accompany all fire reports where needed to give a complete account of the circumstances of the fire.

Personnel

As an introduction to this subject a few facts will be reviewed to reveal the size of the job. The Clackamas-Marion patrol unit has a gross area of 613,000 acres (table 2) of which 76 percent or 468,000 acres is forest land. There are about 14,000 rural residents or about

3,500 families living close to these forest lands. There have been about 60 reportable man-caused fires and about 20 lightning fires per year and most of these have occurred between May 1 and October 1 (table 11). The main fire season usually lasts from 3 to 4 months but there is need for year-round attention to fire control. The unit contains a few large logging operations and about 200 smaller operations including woodcutters. These operations produce about 9,000 acres of slash per year most of which must be disposed of by burning under the warden's supervision. The warden is called upon to issue and administer several thousand burning permits per year for this area. In addition there are roads, trails, telephone lines, lookout towers and buildings to be maintained and fire fighting and other equipment to be cared for.

To fill the position of head warden of this district requires a man with executive ability and experience who is skillful in all phases of prevention work and in building cooperative relationships with loggers, woodcutters and all types of local residents. He should be able to organize for the prompt, effective control of large and small fires. He should have ability as a trainer. He should be employed yearlong. A forest school education should be a big advantage to the man who possesses the essential natural ability and experience.

An assistant warden capable of handling many of the administrative details such as those related to burning permits, cooperation with local residents, hiring fire fighters and ordering supplies, making routine reports and office records, and capable of supervising fire fighting crews on large fires should be employed on a yearlong basis. This should be considered a training job and men with forest school training recruited and assigned to it.

During the main fire season, in addition to the warden and his assistant, there is need for extra help at the warden's headquarters. Someone should be employed to stay at headquarters at all times to answer the telephone, operate the radio, check equipment and supplies in and out, keep records, make reports and act as dispatcher when the warden or his assistant is not available. There is also need for a man with mechanical ability to keep all equipment in good condition, train equipment operators and act as equipment operator on fires. He should have the wages, length of employment, and the living conditions that will hold a high class man. By using him to maintain equipment and improvements before and after the fire season it might be possible to give him 8 or 10 months' work.

Lookouts, patrolmen, and suppression crews should be the highest type of men that it is possible to obtain and they should be given the longest possible employment. To prevent excessive turnover it will be necessary to pay wages comparable to those paid in other woods jobs. Some men prefer to work for a fire control organization because they like the work. They take other work only because they can get bigger wages.

It has already been indicated that under average conditions a large force should be available to attack all fires in the high hazard type within one hour. It should be possible to mobilize the largest possible

crews on fires in the most dangerous fuel types, such as slash. This might imply that large stand-by crews of 25 or more men are recommended but that is not the case. It might be more practical to have several 5- or 10-man crews strategically located so that several small crews could reach a fire anywhere in the high hazard types in one hour where they would have the effect of a crew of 25 or more men. It is believed that organized crews are essential to attain adequate fire control in this area but this need might be met in many different ways. The CCC crews have served well but they may not be available in the future. The war emergency Cooperative Forest Fire Control crews used in 1941 were very effective. Crews from logging camps and mills or other local sources, if they are organized and trained in advance and readily available during all possibly dangerous fire weather, should also be effective. It should be possible to organize cooperative crews among the farmers and other rural residents.

Training

Fire control personnel must possess certain special skills. This is an absolutely essential foundation upon which to build an efficient fire control organization. Some of these skills are peculiar to fire control; others are such as any woodsman should possess. Training should be used to develop a high level of skill in all members of the organization. A fire control organization can be judged by its training.

Summary of Part III, Recommendations for Attaining Adequate Fire Control

1. Fire control should be given to all forest lands and it should have universal financial support (59).11/

2. Definite objectives, plans and policies must be provided the personnel to guide them in the conduct of all activities, and lines of authority should be clearly established (59-60).

3. The objective should be to hold the average annual loss from all fires to much less than 1/4 of 1 percent of the forest land area (58-59).

4. To keep within a burning rate of less than 1/4 of 1 percent all fires must be attacked promptly with a strong force and all fires that are not controlled by the initial attack should be controlled in the first work period (58-59).

5. Successful prevention requires mutual cooperation between the fire control agency and the public, the use of closures, positive fire precautions on all industrial operations in the woods, strict law enforcement, use of fire danger measurements, control over the use of fire for hazard reduction and land clearing, and prompt hazard reduction (60).

6. Seen area maps should be used to determine how blind areas can be eliminated or protected (61).

11/ See footnote 6, p. 41.

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7. Ways and means should be found for making the public even more effective in finding and reporting fires (61-62).

8. Accurate maps should be prepared and greater use should be made of maps (66).

9. The warden should have fast, dependable communication with all members of his force and with all cooperators including all woods operators (62).

10. Increased use of tankers and tractors is recommended (62-63).

11. Advance plans and preparations should be made for fighting large fires (63-64).

12. Additional fire danger stations should be established and greater use should be made of fire danger measurements (65).

13. Records should be kept that can be used to improve fire control practices (66-67).

14. The warden should have an ample number of assistants (68).

15. In order to get and hold first-class men in the organization the wages paid should be comparable to those paid for other woods jobs competing for the same type of men (68).

16. Suppression crews should be provided in different parts of the patrol unit and made available at all times during all possibly dangerous fire weather (68-69).

17. Training should be used to develop a high level of skill in all members of the organization (69).

SUPPLEMENT

SPECIAL RECOMMENDATIONS FOR MEETING WARTIME CONDITIONS

There can be a wide range of war conditions from a threat of war up to and including invasion or warfare. These recommendations are applicable to about the highest level of war conditions under which forest fire control would still be largely a civilian activity. The war intensifies the need for the fire control measures already recommended and it creates the need for additional measures that will be discussed below.

Objectives

The war imposes additional forest fire control objectives and re-emphasizes and reorients peacetime objectives. The disastrous direct and indirect effects that forest fires can have upon military and civilian activities make it tremendously important to attain high standards of forest fire control during the war. But the emphasis is upon all fire and not upon forest fires alone. The wartime fire control objectives are not limited in any way to forest lands, to administrative boundaries, patrol units, to the properties with the highest dollar values, or to any class of owners. Instead the war establishes a new scale of values, and fire prevention and control in or near areas used by the military forces or defense industries have the highest priority. Fires of all kinds are incompatible with "blackouts." The smoke from forest fires would interfere with military aviation. Fires would demoralize the civilian population. They might cause loss of life. There are many reasons for the wartime objective that all fires must be prevented or promptly controlled.

Administration

To meet the wartime objective of preventing or promptly controlling all fires the fire control agencies must have complete coverage, unified action and full cooperation among themselves and with the military authorities. The Oregon Forest Defense Committee was organized in January 1942 to coordinate the activities of the various Federal, State, and private fire control agencies at the State level. Coordinating organizations composed of all fire control agencies by counties or groups of counties would find much worth-while work to do. However obtained, it is absolutely essential as a wartime measure to have complete and unselfish cooperation between all fire control agencies--Federal, State, county, municipal, Association, corporation and individual. It may be necessary to forget property lines and old and long-established jurisdictional boundaries and to realign administrative units to meet wartime needs. Division of authority should be clear and unmistakable. Someone should have the necessary responsibility to take direct, positive action in every fire situation. Universality of coverage for the common good against a common enemy should be the guiding principle in organizing fire control and in assigning administrative responsibilities.

Prevention

Forest fire prevention in wartime is largely a problem of intensifying peacetime measures. Strict closures are recommended as being

essential to the administration of forest fire control under war conditions. Wherever practicable entry on forested land should be prohibited during all periods of possibly dangerous fire weather except where such entry is really necessary. Right to enter forested areas should be by permit. Although it should be practicable to enforce this kind of closure in the virgin forest and cut-over or burned land use districts in Clackamas and Marion Counties it probably cannot be applied throughout the farm and forest or the agricultural district. There are some places, however, in these districts where solid blocks of forest lands occur where it might be applied. Special attention should be given to unburned logging slash and operating areas in general to put them under an effective closure. Enforcement of forest fire laws and especially the administration of operating permits, burning permits, and inspections should be such as will produce positive results. It should be inexcusable to have any permit fire get out of control and become the concern of the fire control agency. Woods operations of all kinds should be closed down or other positive action taken to prevent fire starting from them during all periods of extremely dangerous weather conditions.

Hazard reduction deserves special attention. Expansion of logging to meet national defense demands for lumber produced a large acreage of slash in 1941 and very little was burned because of the wet fall. Effort should be made to dispose of this unburned slash before the 1942 fire season even if this means extra cost for mop-up. Slash that must be held over the 1942 fire season should be protected by special closures, watchman service, or such other prevention measures as may be necessary positively to prevent all accidental or intentional fires. Slash should be disposed of promptly in the future. Scattered through the high and extreme hazard fuel types there are useless, abandoned sawmills, camps, and other empty buildings which should be destroyed or guarded to prevent their ignition by incendiarists or others during periods of critical fire weather when the fire would be liable to spread rapidly to the surrounding forest land. Law enforcement should be used to the fullest possible extent as a fire prevention measure. Potential incendiarists should be watched. Enemy aliens should be excluded from forest land.

Detection

Under wartime conditions, and thinking particularly of the possibility of incendiary bombs from the air or the activities of incendiarists on the ground, the closest practicable approach to 100 percent detection coverage under all visibility conditions and for 24 hours per day should be a basic objective. Seen areas should be mapped and special measures taken to get detection in the blind areas. Personal contact should be made with dependable local residents in or near blind areas to obtain their assistance in detecting and reporting fires. It would be advisable to make advance plans and preparations for the intensification of detection service in case of a sporadic attack with incendiary bombs. Consideration should be given to the possible use of airplane patrols to detect fires in remote places under poor visibility conditions.

Communication

Under war conditions probably the telephone must be developed as the principal means of communication. The needs in this field are known and appreciated and need not be treated at length here except to mention one special item. If local residents are to be used as detectors and as fire fighters it is imperative that they have telephone communication with the warden. Observation indicates that many rural telephone lines are in very poor condition. The analysis also indicated that only about one rural residence in five had a telephone. Therefore it appears that one important way to improve the communication system will be to give attention to the rural telephone lines. It is recognized that any attempt to improve these lines will run into many difficulties, but if it is important to the war effort ways and means should be found to get the desired results. The closest possible coordination should be maintained between the fire control agencies' communication system and that of the military agencies. It is highly desirable that all logging or sawmill operators can be reached quickly by the warden by telephone or by other means.

Transportation

Trucks and cars will not be so readily available during the war as they have been in the past. This will call for special planning and special cooperative arrangements with owners having usable equipment. Probably greater dependence will have to be placed upon obtaining cars and trucks from local sources--loggers, sawmillers, and farmers. Eventually it may be necessary to make use of horse transportation, especially on the slower rougher roads.

Equipment

It may be highly desirable to expand the use of tankers and tractors as an effective substitute for the manpower that will be hard to get during wartime. One of the principal functions of a coordinating organization would be to facilitate the pooling of all fire control equipment of all fire control agencies so that it could be used where most needed. This organization should also make advance arrangements with forest, rural, and municipal fire control agencies for the temporary transfer of equipment when any agency has exhausted its resources.

Weather and Fire Danger

During the war fire weather forecasts and warnings will not be as readily available as in peacetime. They may also be somewhat incomplete. Therefore it will be necessary for each fire control unit to develop its own sources of information. To meet this situation the greatest possible use should be made of local measurements of fire danger factors. These measurements can be made with the simple instruments used at fire danger stations. Measurements should be made daily at many points and the information assembled and redistributed from central stations. Logging and milling operations in particular should make accurate measurements to

determine the fire danger. Shutdowns and other special fire prevention measures should be based upon actual measurements of conditions. A wind gage and a set of fuel moisture indicator sticks and scales or a wet and dry bulb psychrometer to measure relative humidity should be the minimum set of instruments used. Everyone having instruments should receive instruction and training in the use and interpretation of the measurements. In this connection wider use might be made of the burning index values which show the combined effect of wind and fuel moisture content.

Records

Records are absolutely essential to the operation of a fire control agency in wartime. The increased turnover of personnel will increase the importance of personnel records and diaries. The same turnover of personnel will increase the desirability of having information in written form instead of having it carried around in the heads of individuals. Since several agencies may take part in fire control work in any one area or on any one fire full and complete time and cost records will help in making financial settlements and help to prevent unnecessary friction and misunderstandings. Full and complete records should be kept of all cases that may involve incendiarism or sabotage and the same recommendation applies to all cases that may lead to law enforcement or damage suits. Written records should be kept about weather and fire danger, closures, inspections, and all special instructions and requirements issued during the war.

All-out Preparations for Fire Fighting

The fire control agency should make complete plans and preparations to handle a widespread outbreak of incendiarism or a sporadic enemy attack with incendiary bombs from the air. To do this plans must be made in advance to handle at one time many fires set in a short period of time. In peacetime the fire control agency usually has only one or two fires going at a time except after lightning storms. During the war plans should be made for handling a situation in which several hundred fires might be started simultaneously. In such an emergency the military forces might be able to give some help, but they should be counted upon only as a last resort after the fullest possible use had been made of civilians and civilian resources.

To meet the situation in which the fire control agency might be confronted with a fire load that it could not possibly handle with its own forces it is recommended that every able-bodied man and woman living or working in the patrol unit and forested parts of the non-patrol area in Clackamas and Marion Counties be trained and organized as a potential fire fighter. The term "fire fighter" is used deliberately to indicate that there is no intent to limit this recommendation to forest fires. Since it is not limited to forest fires it may be a cooperative enterprise with other agencies but the important thing is to get it done even if the forest fire control agency must do it alone.

The training part of this program might start with the distribution of simple instructions for fighting various kinds of fires. It would be desirable to have some such set of instructions posted in every house,

school, church, store, sawmill, logging camp, etc. Group training meetings and demonstrations should be held. Leaders should be selected and receive special training. By making everyone familiar with fires and fire fighting methods fear and panic can be minimized.

As a further step it would be desirable to develop some kind of fire control vigilance committee in every community, sawmill and logging camp. It would be especially desirable to have strong local organizations of trained fire fighters in all communities that are near large areas of forest lands. The most easterly communities along the length of the patrol area might deserve special attention because they could be the nearest source of reserve manpower for the large acreage of forest lands in the practically uninhabited interior. The school district might be a logical unit of area to use in organizing these local crews of fire vigilantes. However organized, every local resident should have some definite place in the organization and every inhabited nook and corner should be included. Although fires in the home territory of these community organizations would be their first concern they should be prepared to go to other nearby areas when they can be spared, especially into the sparsely settled forest areas in the cut-over or burned land use district. Certain physically fit members of these local crews might be given special training and organized into special crews for forest fire fighting away from home.

In addition to the plans that should be made for using every able-bodied member of every community as a fire fighter plans should also be made for obtaining fire fighters from the outside during a peak fire load. This planning should have its sights set high; the aim should be to mobilize several hundred fire fighters for the Clackamas-Marion patrol unit. These fire fighters might come from other patrol units that are not also having a peak load or they might be organized in advance in Portland, Oregon City, Salem, or the farming communities of the Willamette Valley. Ample advance training should be given to all crews. Competent leaders should be provided. Full plans should be made in advance for feeding and equipping these crews.

Another very different type of preparation should be made for a peak fire load. Advance attention should be given to ways and means to prevent panic and hysteria. Plans should be made for evacuating families and communities that might be cut off or burned out by a forest fire. Steps should be taken to prevent the unauthorized setting of backfires. Advance arrangements should be made with State and county law enforcement officers for their help and cooperation.

Personnel

The success of the forest fire control agency in meeting wartime conditions will very largely depend upon the caliber of its leaders. During wartime the regularly employed force of the fire control agency should be greatly increased. Provision should be made for a number of 5- or 10-man crews. Sufficient wages should be paid to hold old employees in the organization and to attract good men. Particular attention should be paid to having a large number of men who can act as competent

leaders if it is necessary to expand the organization. The warden should have several assistants fully capable of organizing and training the community fire control crews. Full provision should be made to obtain the temporary services of local residents, loggers, and sawmill men who are competent to take over supervisory work when fires occur.

Training

Even in peacetime the importance of training cannot be overemphasized, but during the war it becomes, if possible, even more important. This is true because employees will probably be younger and less experienced and also because they may be called upon to do many things not required in peacetime. It will be necessary first of all to train those who need it in the simple arts of woodsmanship: How to use an axe, saw, hazel hoe, shovel; how to care for tools; how to get about in the woods; how to use a compass; how to read a map; and how to avoid accidents. It will be necessary to teach the fundamental principles of fire fighting to people who have never seen a forest fire. It will be necessary to start with the very simplest kind of small fires, for example a campfire.

In setting up a training program take nothing for granted. Find out what the trainees need to know; find out how much they know and teach them what they do not know but should know in order to be fully effective workmen. Training deals mostly with commonplace, ordinary, obvious things; but it is a real job that demands conscious effort and skill. It is a continuous process. There must be a real incentive and the training should be made as interesting as possible. War is a demonstration of the value and necessity of training. Every branch of the armed service has training as a major job. Men engaged in forest fire control need training in their job just as certainly as soldiers need training for their job.

Summary of Special Recommendations for Meeting Wartime Conditions

1. All fires must be prevented or promptly controlled.

2. The fire control agencies must have complete coverage, unified action and full cooperation among themselves and with the military authorities.

3. General use of strict closures is recommended.

4. Logging slash should be disposed of promptly.

5. Fire prevention measures should be intensified to make them produce positive results.

6. There should be the closest practicable approach to 100 percent detection coverage for 24 hours per day under all visibility conditions.

7. Rural telephone lines should be improved in order to get quick, dependable communication with local residents and woods operators.

8. Special arrangements should be made for the use of private cars and trucks.

9. The equipment of all forest and other fire control agencies should be pooled so it can be used where most needed.

10. The greatest possible use should be made of local measurements of fire danger factors.

11. Records are absolutely essential to the operation of a fire control agency in wartime.

12. Advance preparations should be made to handle widespread incendiarism or a sporadic attack with incendiary bombs by organizing and training every local resident to be a fire fighter.

13. Advance plans should be made for obtaining, feeding, and using several hundred fire fighters from outside the patrol unit.

14. Plans should be made for preventing panic and hysteria, to prevent the unauthorized setting of backfires, and to obtain the help and cooperation of law enforcement officers in case of a heavy load of wartime fires.

15. The regular force of the fire control agency should be increased and high personnel standards maintained by paying wages that will meet competition with other woods jobs. The fire control organization should contain a large number of men competent to act as leaders in times of increased fire load.

16. Members of the fire control organization and all cooperators, including local residents and woods operators, should receive the training needed to make them effective in their wartime fire control jobs.